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INSTRUMENT Practice AUTOMATION & ELECTRONICS

Vol. 13 No. 1 Published Monthly January 1959

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Ernest Turner

Precision Electrical Measuring Instruments

The Model 703, illustrated above with mirror scale, is one of the latest range of Ernest Turner rectangular instruments. This pattern ideally matches contemporary panel design, and the high degree of accuracy is adequately supported by an especially easy-to-read scale and clean dial layout. Full details with ranges, prices, etc., are contained in Leaflet 85/G which will be sent on request.

ERNEST TURNER ELECTRICAL INSTRUMENTS LTD

HIGH WYCOMBE BUCKS ENGLAND

MULTI-CIRCUIT ROTARY PACKET SWITCHES

TJ 1180
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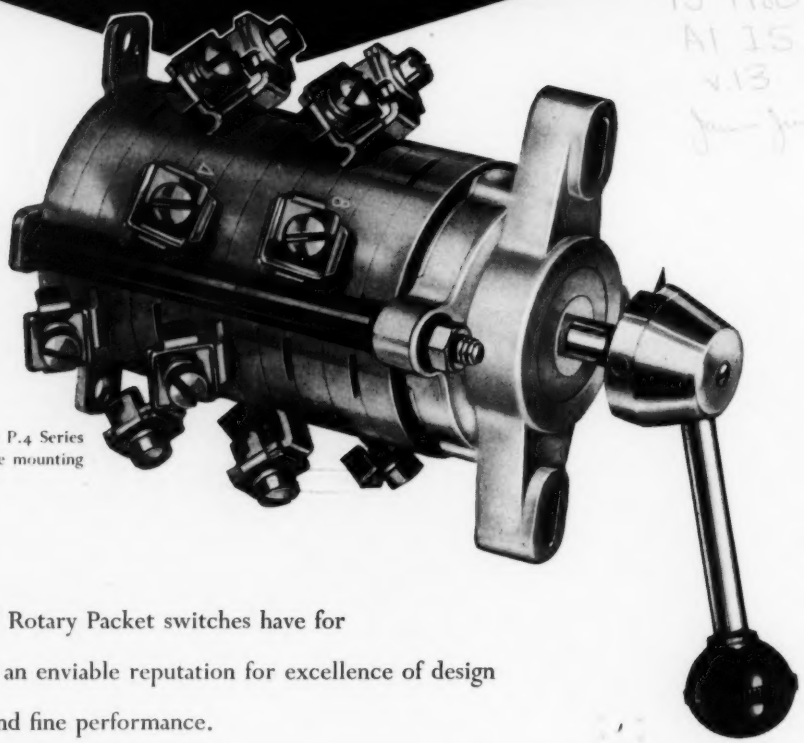
v.13



The illustration shows our P.4 Series arranged for panel and base mounting with machine type handle.

ARROW Rotary Packet switches have for many years enjoyed an enviable reputation for excellence of design and fine performance.

Considerable saving in cost can be effected by the simultaneous switching of various circuits using ARROW Rotary switches.

Write TODAY for a copy of LIST R.P.2 describing our P.4 Series illustrated here.

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- Listening head withstands high ambient temperatures
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A noise, produced *only* when the fuel burns, is conveyed via a tube to a protected microphone secured on the outside of the burner box. The resultant electrical signal is cable linked to an amplifier in the control area. Reduction in "flame noise" below a preset level causes front panel "flame out" indicators on the instrument to light. Provision is also made for simultaneous operation of remote audio or visible alarms and fuel control circuits.

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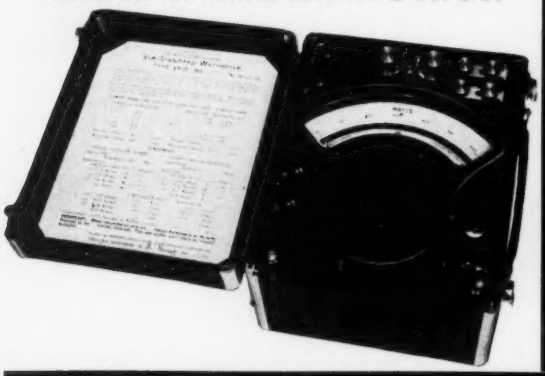

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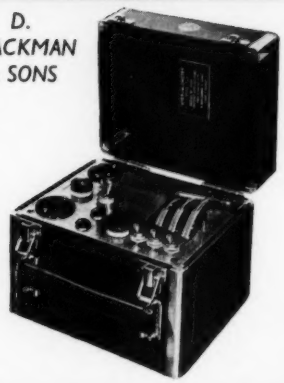

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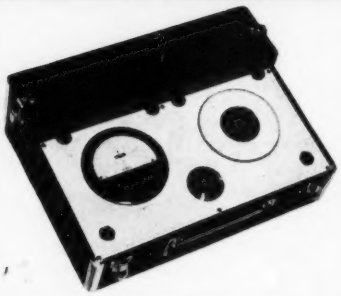

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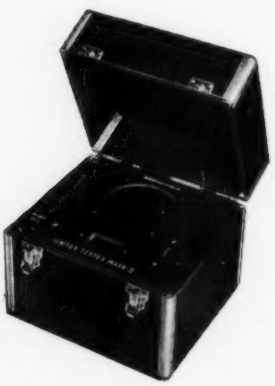

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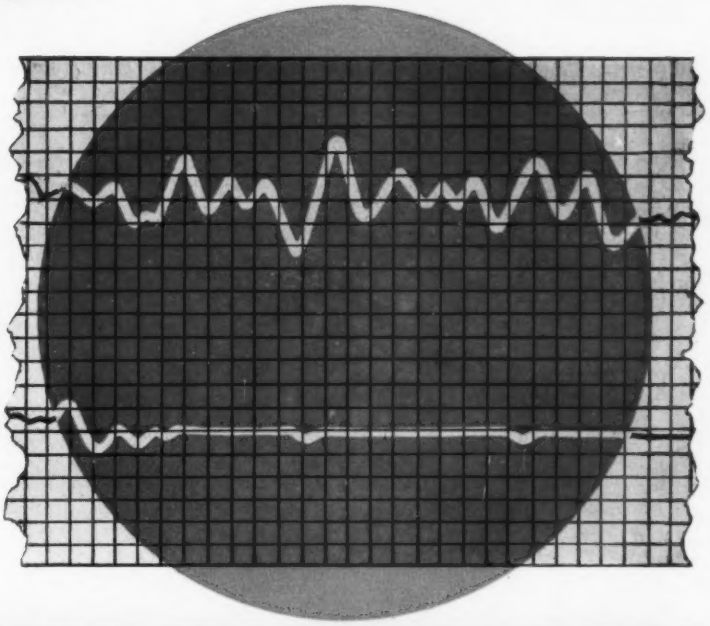

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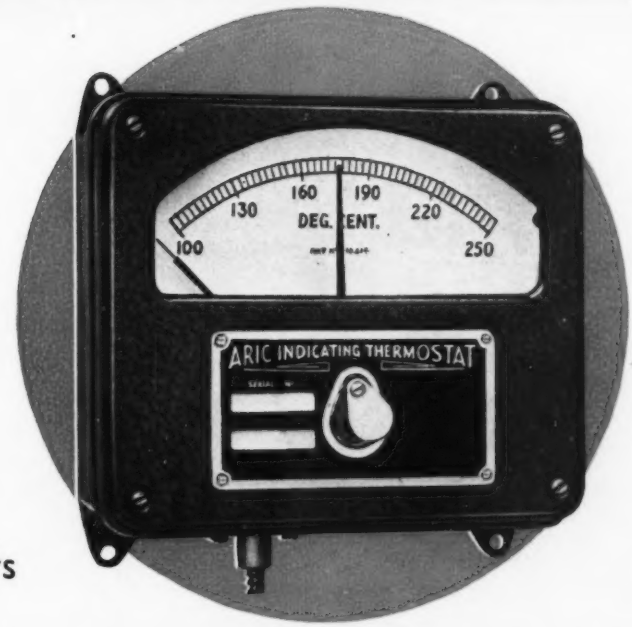

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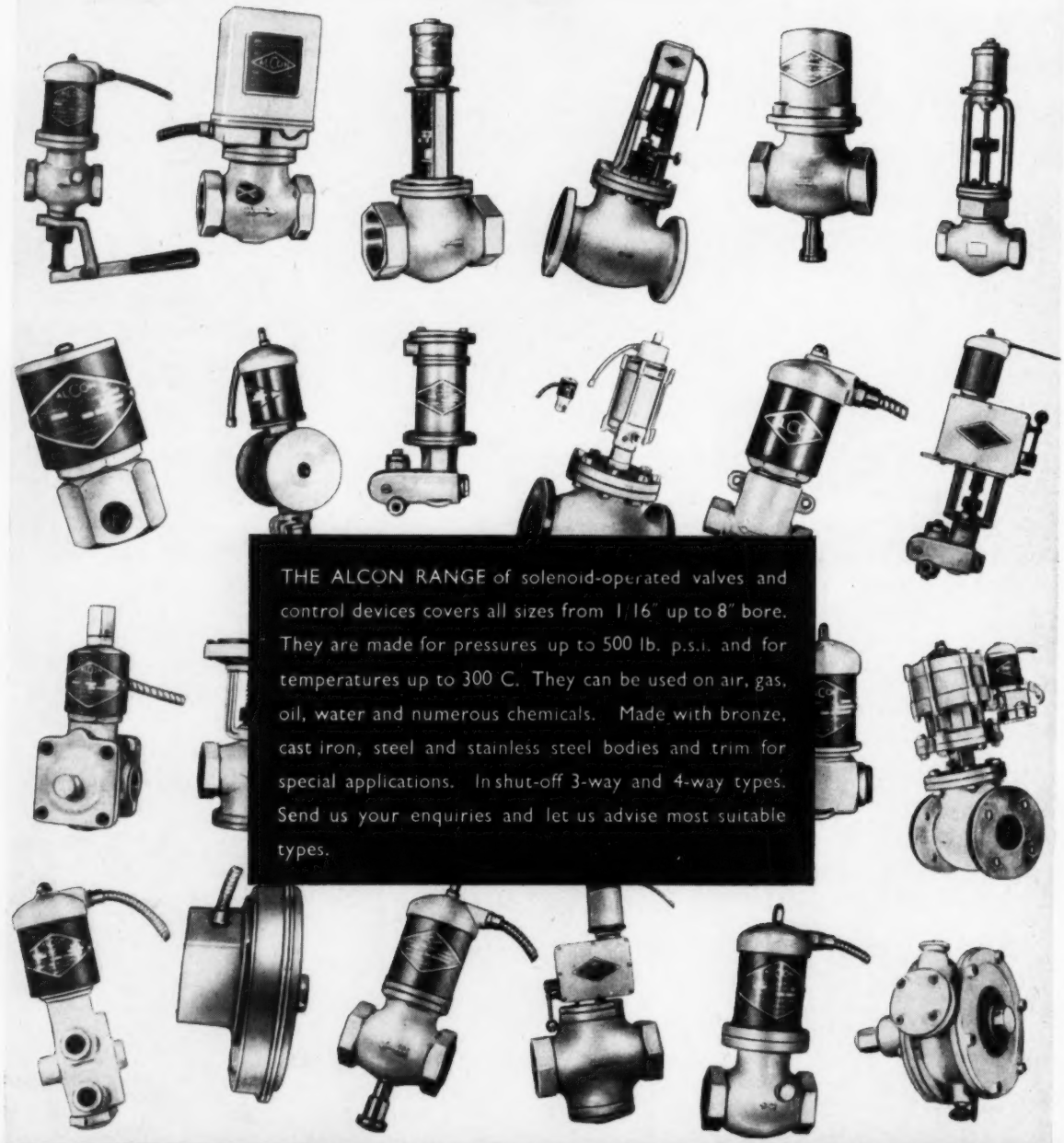

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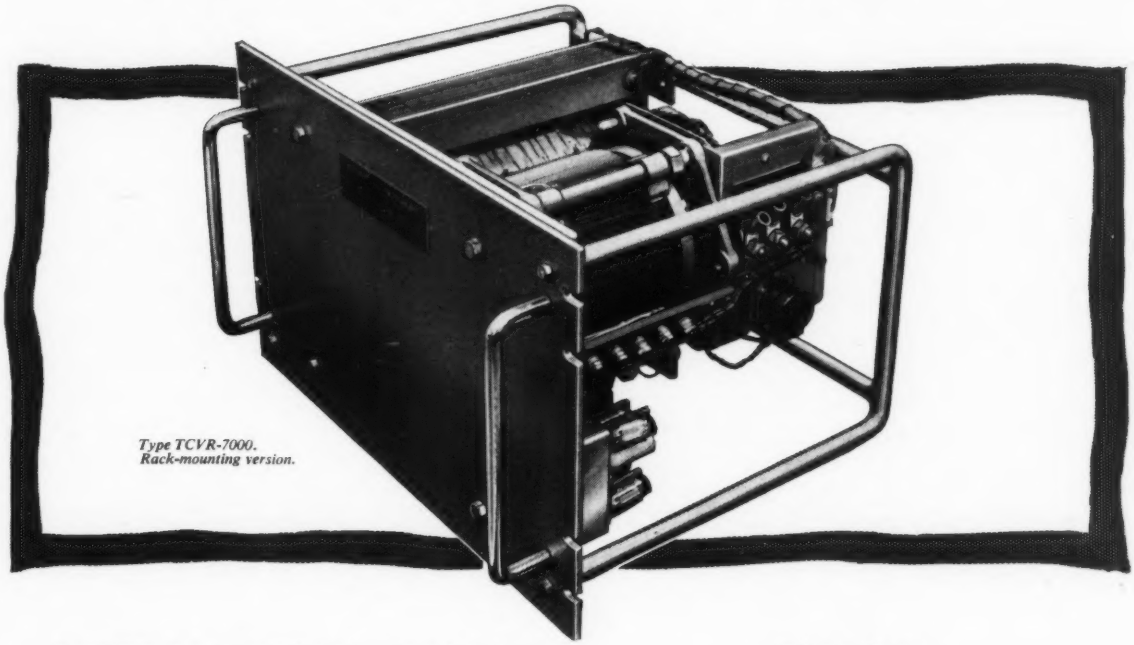
—with the type TCVR voltage regulator



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For high-speed, accurate stabilisation *without distortion*—**specify TCVR.**

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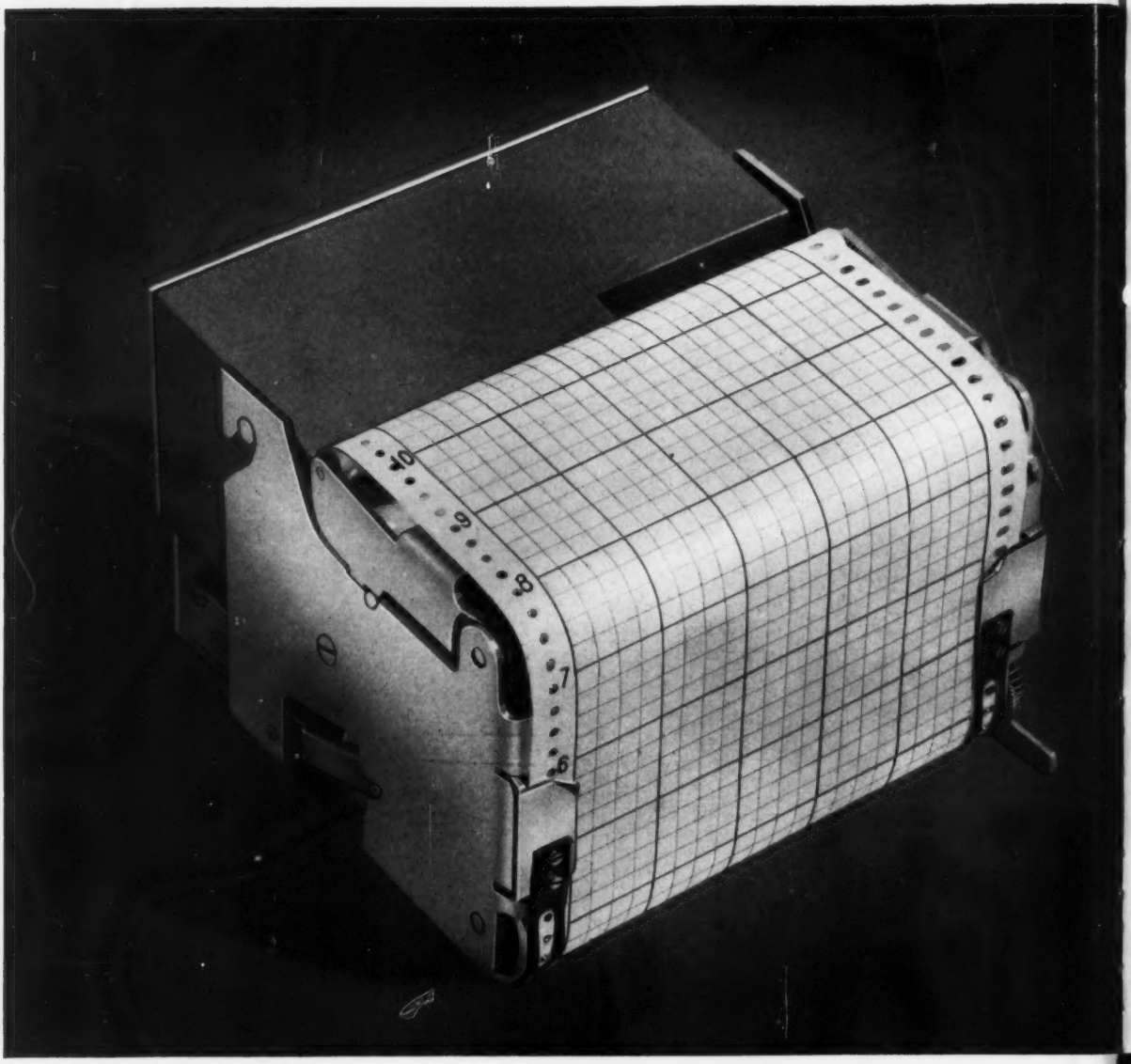

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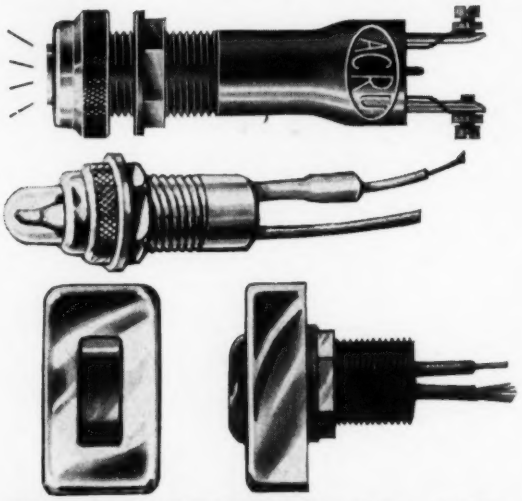

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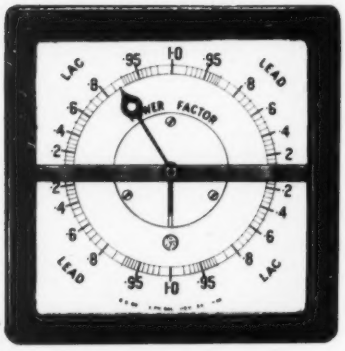

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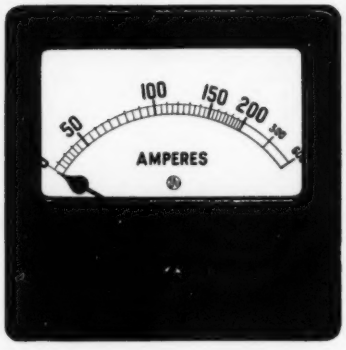

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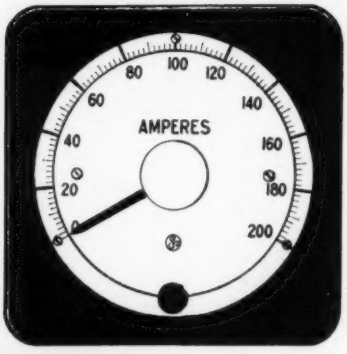

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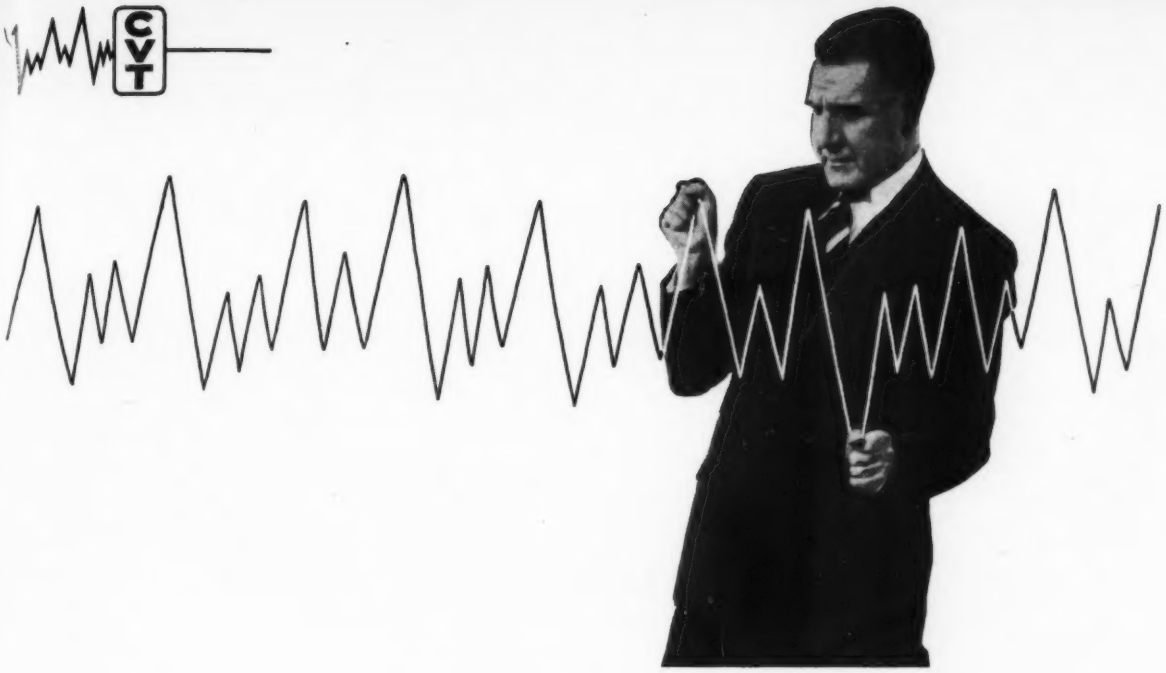

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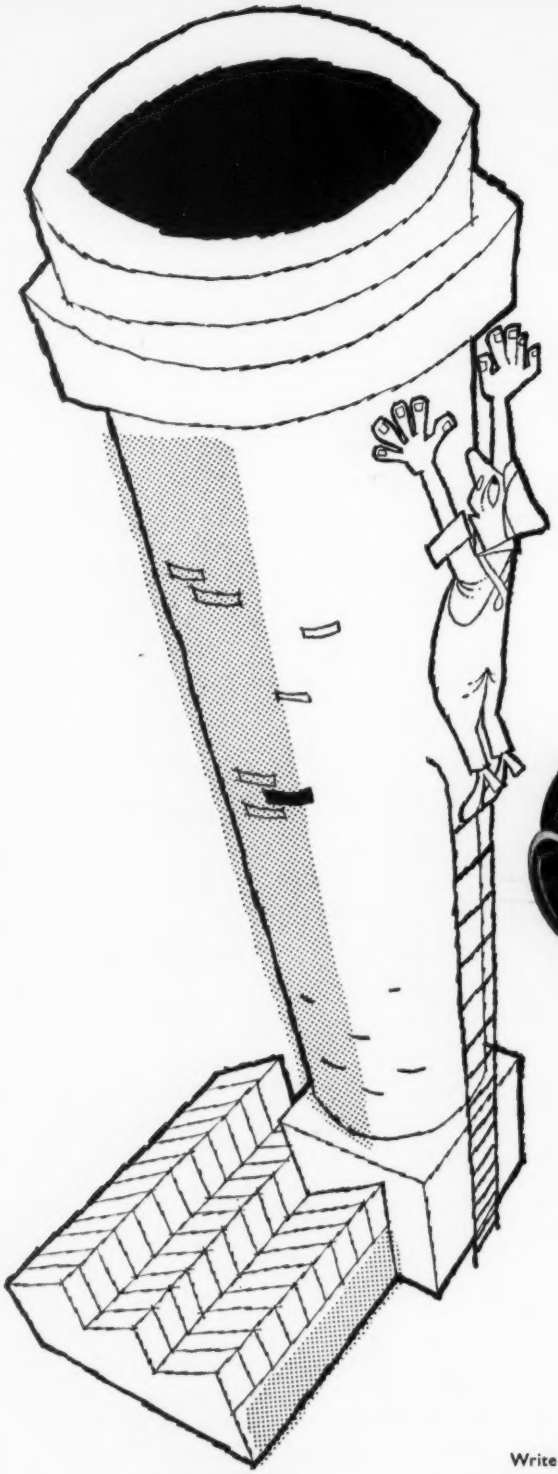

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Printed resistance panel for universal meter shunt.

Composite printed resistors and auxiliary switch.

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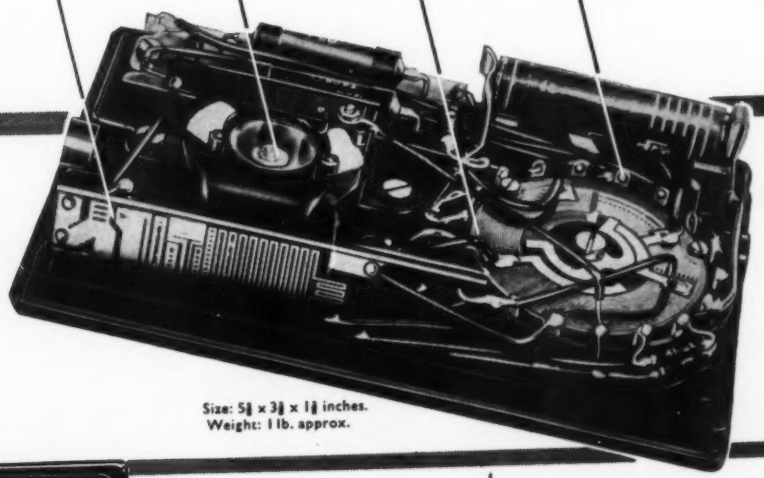

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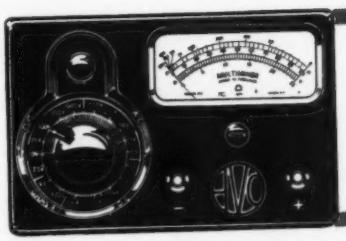
Weight: 1 lb. approx.



7 D.C. Voltage Ranges: 0-1,000 V.

5 A.C. Voltage Ranges: 0-1,000 V.

5 D.C. Current Ranges: 0-1A

2 Resistance Ranges: 0-20,000Ω. 0-2MΩ.

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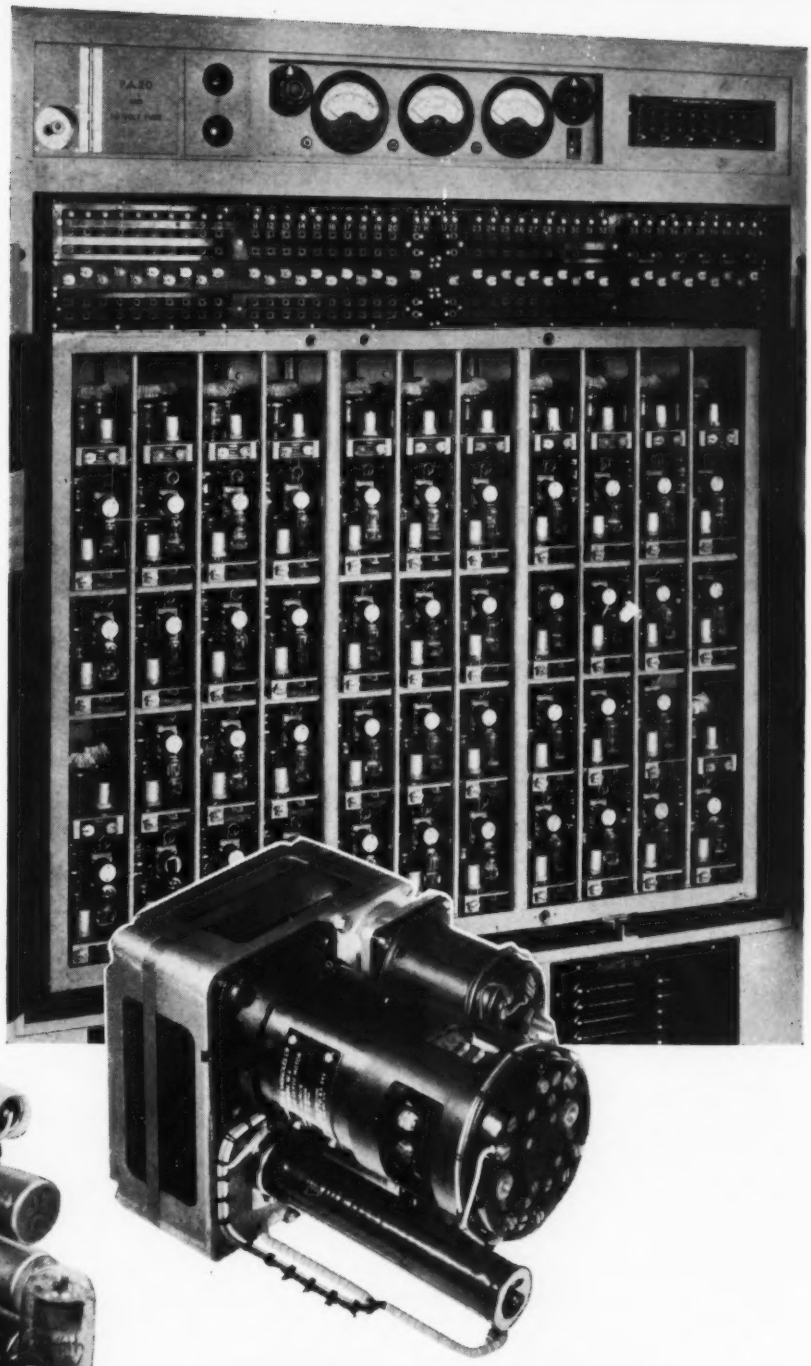

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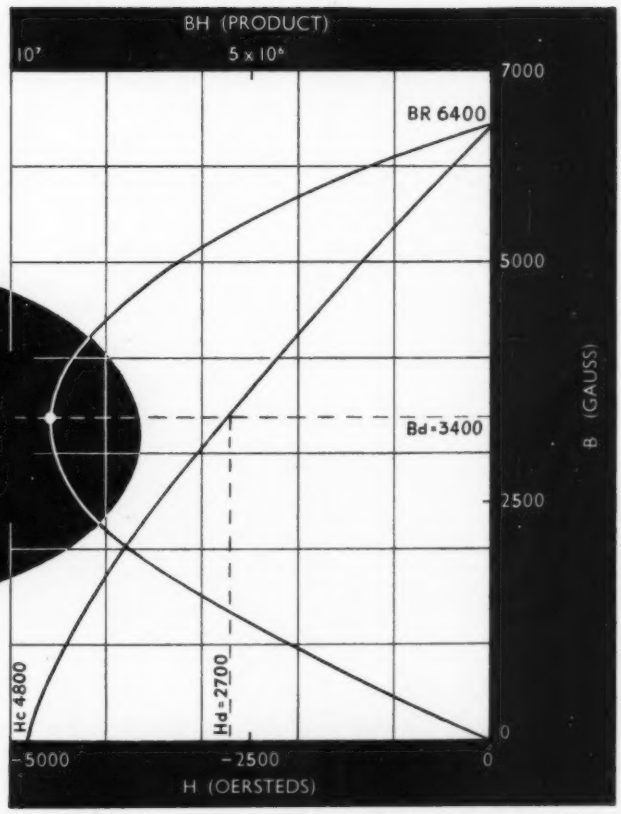

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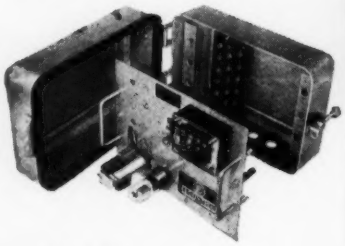

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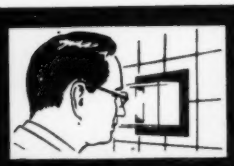

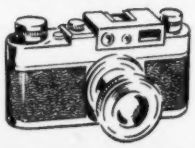

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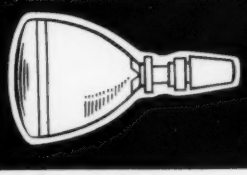

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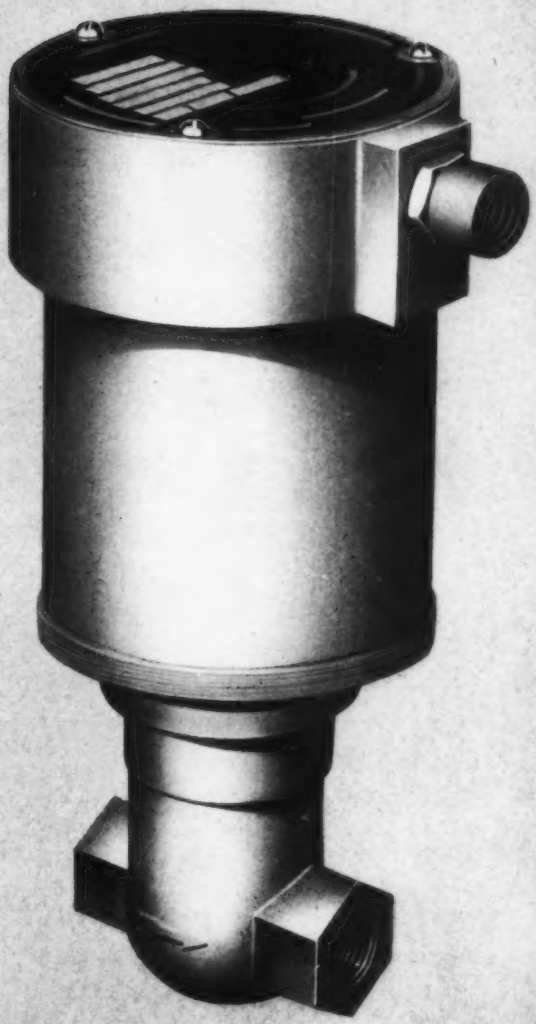

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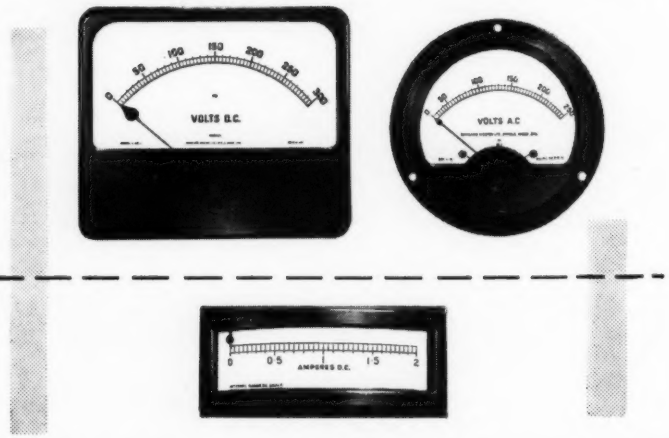

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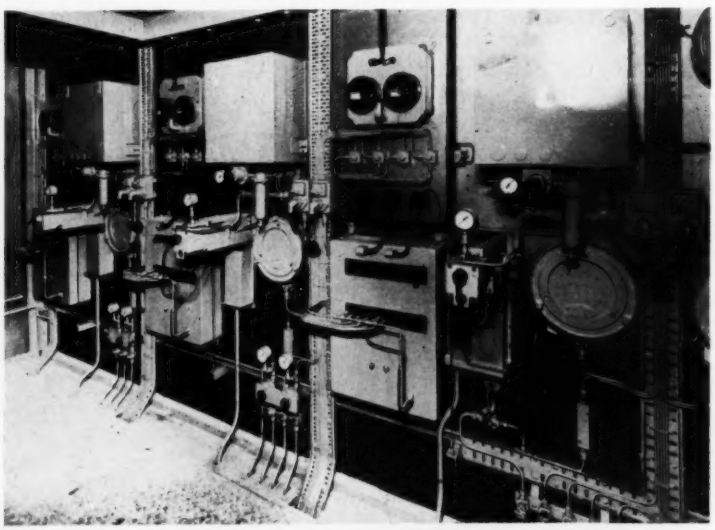

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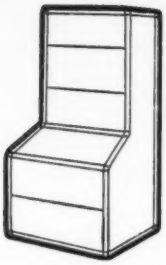

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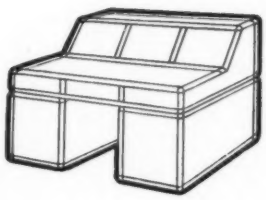

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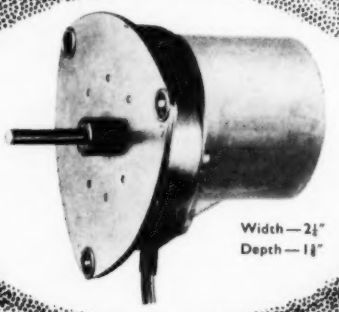

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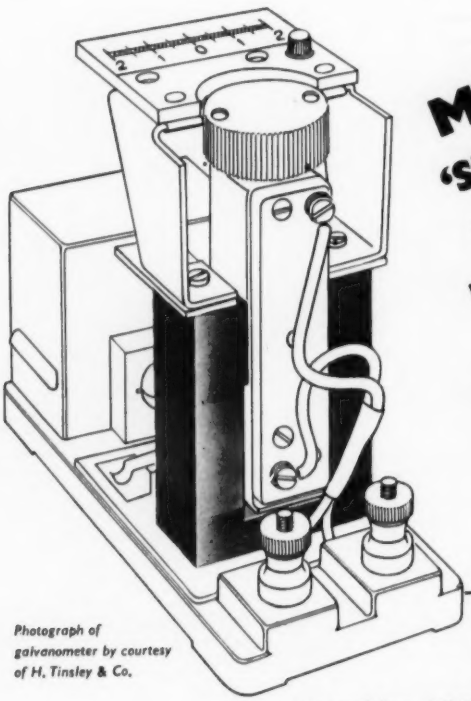

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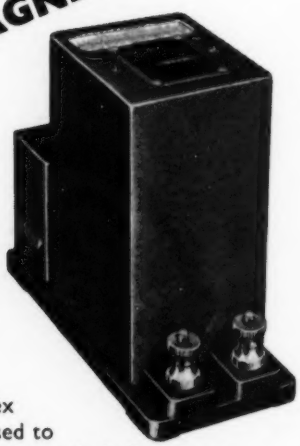

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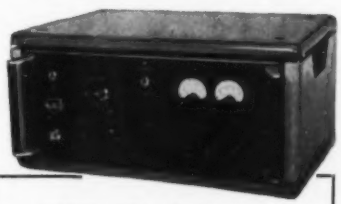

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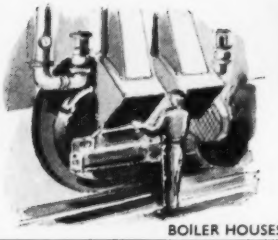

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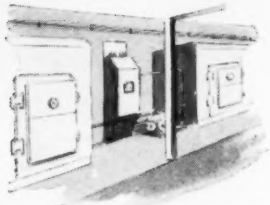

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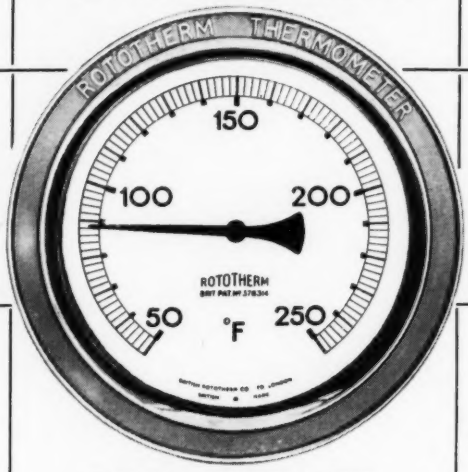

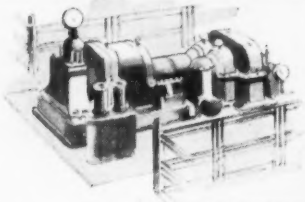

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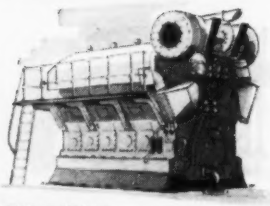

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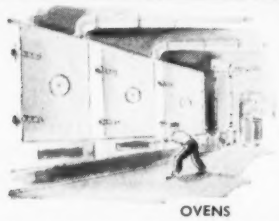

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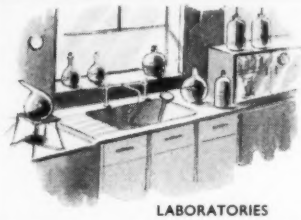

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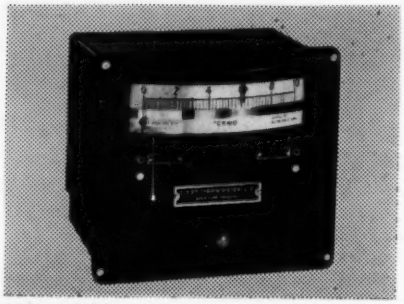

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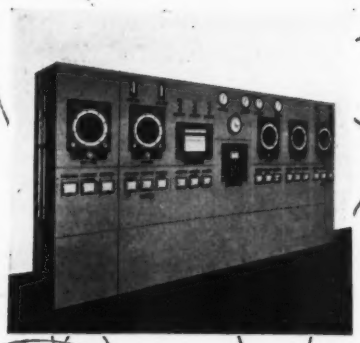

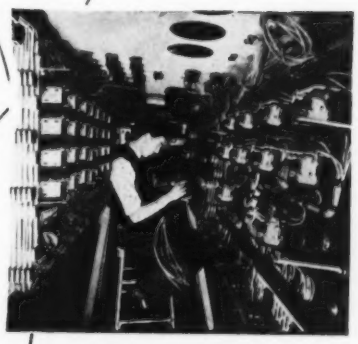

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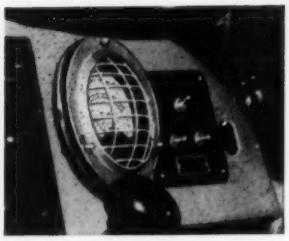

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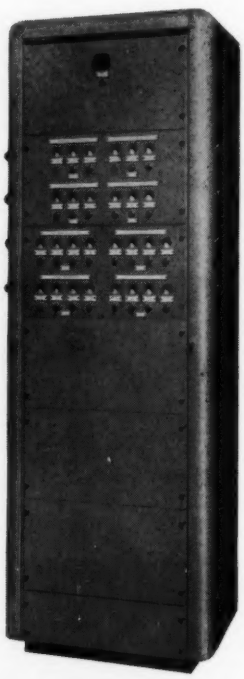

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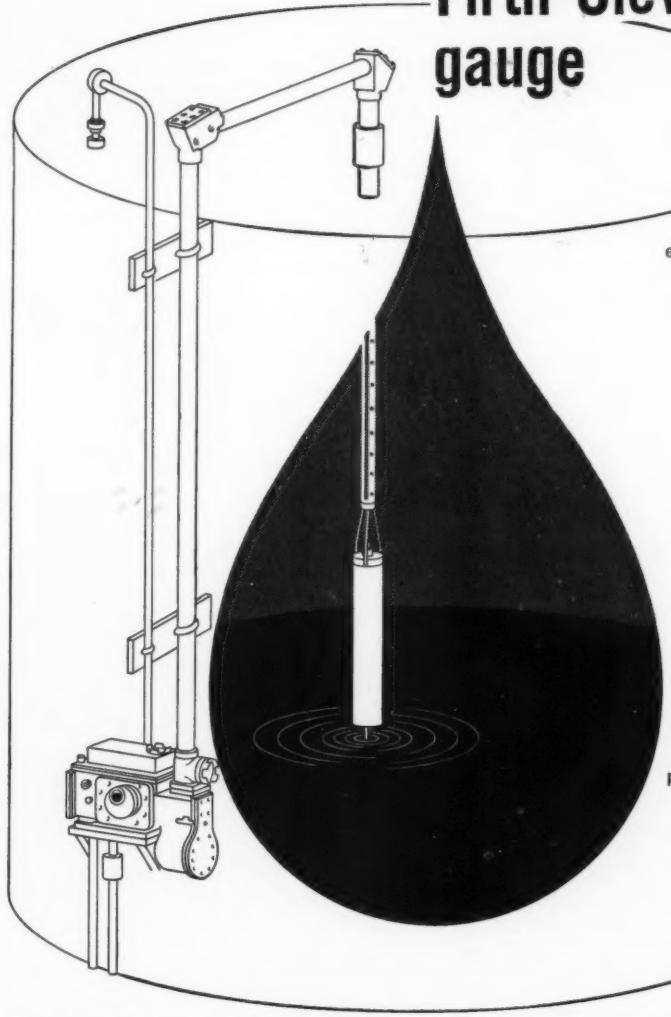

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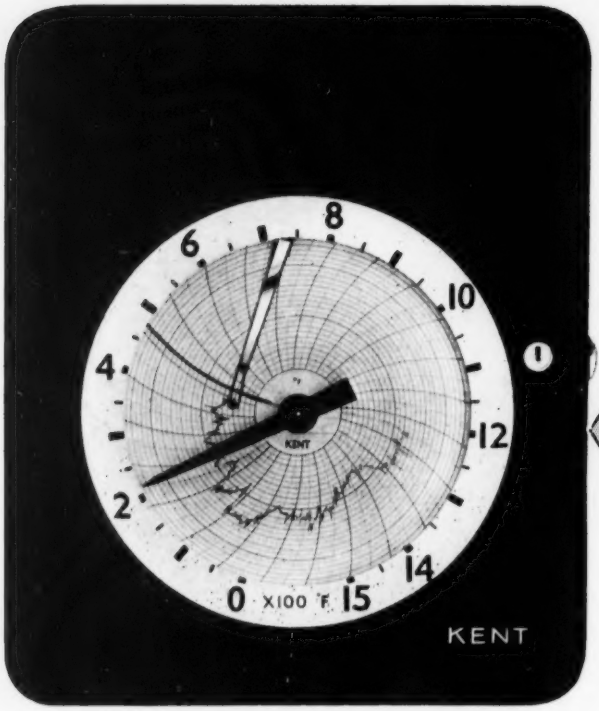

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INSTRUMENT Practice AUTOMATION & ELECTRONICS

Editor: J. T. MILLER, B.Sc., F.Inst.P.

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Commentary

Electronic Computer Exhibition

Approximately 40,000 people visited the Electronic Computer Exhibition at Olympia. For the six days the exhibition was open, this is equivalent to 7,000 visitors per day. At the symposium meetings attendances of up to 800 were recorded. As Mr. Vernon Roberts, the exhibition chairman, said: "The attendance at the exhibition and the interest shown has exceeded all our expectations and it leaves no doubt of the very healthy condition of the British electronic computer industry." Visitors comprised all levels of personnel and came from thirty foreign countries in addition to the United Kingdom, Dominions and Colonies.

What is the reason for this exceptional interest?

Undoubtedly, much stimulation came from the organising committee of the exhibition itself which publicised matters well in advance of the opening date. Again, over the last few years the technical and lay press between them have steadily built up a great interest in the computer field by news items and articles. These have reached a very wide range of readers in the technical and business fields. There is no doubt, too, that the specialised nature and compactness of the exhibition helped to a large extent, in that a visitor could concentrate on computers and data processing equipment, every stand having something of interest. On the purely commercial side, an order for a £50,000 computer for accounting purposes, and one for £20,000 for high speed tape printers whilst not, perhaps, typical nevertheless indicate that interest was not merely academic.

We have been accused of being many years behind the United States in computer design and applications. The recent exhibition should, however, have established our own efforts in the computer field generally and in the near future we may be able to create a leadership—at least in some parts of the field.

One precautionary note may perhaps be urged. It is to be hoped that the fillip given by the exhibition will not lead to the purchase of computers where they cannot be used in an optimum manner. There is a certain danger that computers may be installed where other data processing methods would be equally or even more efficient. There is little good for the industry to be obtained from a situation where a computer is purchased to be in the fashion and where, having purchased it, its use must be justified even to the extent of trying to make it perform functions for which it is not suitable.

Physical Society Exhibition

As readers will have observed, this issue includes some pre-view notes on the Physical Society Exhibition. We would remind readers, again, that the exhibition will be held in the New and Old Halls of the Royal Horticultural Society, Vincent Square, London, S.W.1, from the 19th to the 22nd of this month.

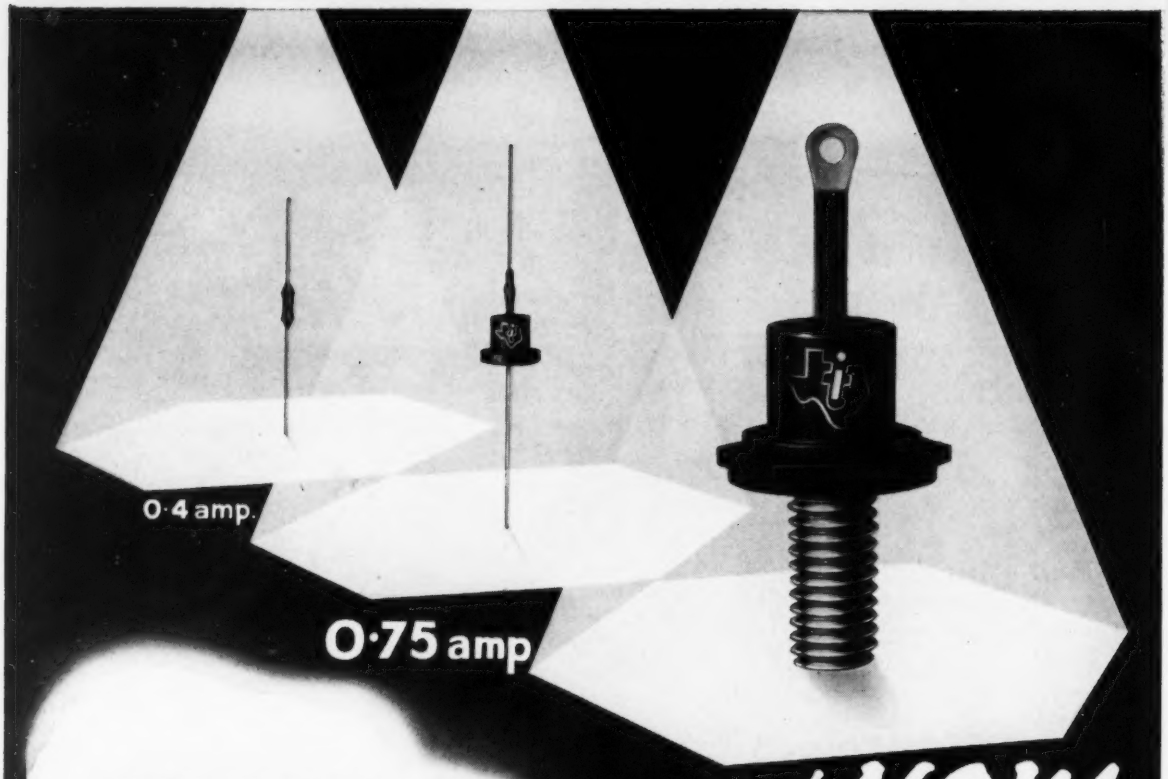
"British Instruments Directory and Buyers' Guide"

Very early in this year the "British Instruments Directory and Buyers' Guide" will appear. Readers will know that the original Handbook of the Scientific Instrument Manufacturers' Association and the Instrument Directory, compiled by this journal, have been merged and will appear as one large volume bearing the above title. The volume will cover the *whole* of the instrument industry and in view of trade developments on the Continent and elsewhere it will be widely circulated abroad, the language glossary in Spanish, French and German being designed to assist foreign buyers.

Brit.I.R.E. Medical Electronics Group

The British Institution of Radio Engineers announces the formation of a Medical Electronics Group. This is in accordance with the policy of the Council to establish specialist groups to foster the holding of meetings, the writing of papers and the general dissemination of information in the specialised fields of radio and electronic engineering.

The chairman of the Group Committee, Mr. W. J. Perkins, was the Institution's representative at the International Medical Electronics Conference held in Paris last May.



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Automation Instrumentation at Vauxhall Motors

Part I

by Rolt Hammond, A.C.G.I., A.M.I.C.E.

In this series of articles, the author surveys various aspects of automation at the Luton Works of Vauxhall Motors Ltd.

Introduction

THE immense £36m. development programme undertaken by Vauxhall Motors Ltd., at Luton, has raised the annual output capacity of this concern to 250,000 vehicles. Plant expansion and modernisation has been going ahead since 1954, the new Bedford lorry plant at Dunstable having been completed in 1957. The programme has been based on an increased productive capacity from 130,000 to 250,000 cars, vans and lorries yearly; it includes an increase of Vauxhall manufactured components in the company's vehicles; and it aims to bring production facilities into line with the most efficient standards. Although planned as a five-year project, it has in fact been undertaken in 3½ years, a remarkable achievement.

The main structural feature is a new building covering an area of 1½ million square feet adjacent to existing manufacturing plant at Luton. In addition, the Dunstable lorry plant has been extended from an area of 120,000 to 1¼ million square feet, the Luton machine shops have been re-equipped, and a new building at Dunstable covering 500,000 square feet houses all the parts and accessory activities of the company. Floor space at Luton, now almost entirely given over to production of cars and light vans, has been increased from 3½ to 5 million square feet. Bedford lorry production is now entirely concentrated at Dunstable, where the total floor area, including the parts warehouse and office block, now amounts to 1¾ million square feet.

The new car building at Luton is one of the most important features of the factory, containing press shop, body building, paint and trim shops, with final assembly operations. Finished mechanical components are fed into it by conveyor from other buildings in which there are some of the most modern tools in the motor industry. Production started in this new building with the introduction of the Victor model in 1957; the new press shop has 222 new presses, 130 of which are heavy machines, more than £6 million having been spent on these presses. The new car production building is 1,450 ft long and 900 ft wide, nearly half of which has two storeys. There is also a basement of 150,000 sq. ft and a pent-house with an area of 83,000 sq. ft. Five new sub-stations provide electric power from the grid of the Central Electricity Authority. It is claimed that here is the largest single lighting installation in the world, with 16,000 twin-tube fluorescent fixtures connected by 66 miles of cable.

Automation Equipment

Automation of the most modern and efficient type is installed for body construction, the equipment comprising several machines in which components and sub-assemblies of sheet metal are spot welded together automatically at high speed to produce assemblies. The process is known as press welding, a multi-spot welding method in which all the welding heads or guns engage with the work simultaneously; they are fired electrically either at the same time, or successively in groups.

It must be emphasised that work which can be carried out on a press welder will depend upon size, shape and accessibility of spot welds. It is clear that panels and assemblies of complex shape are unsuitable for press welding, for the simple reason that welds in awkward positions cannot be reached. Thus, the assembly of a body front end, generally large and of complicated form, is not suitable for this process. Time is another very important factor which must be borne in mind when planning assembly by press welding; both sub-assemblies and assemblies can be welded together at increased speed by this process, so that it is vital to ensure either that they can be absorbed into the main body assemblies, or that adequate space will be available for storing them until required.

An ideal assembly for press welding is shallow and of reasonably flat form, with the spot welds in straight rows and in one plane only, conditions which do not usually occur in practice. In the Vauxhall Velox and Victor models, however, press welding is successfully applied to the following assemblies, namely: complete doors; underbody front and rear units; centre pillars, front body pillar and luggage trunk lids. In considering this form of automatic welding, a comparison between old and new methods will be helpful in bringing out the advantages gained by the latter. Thus, with an earlier Vauxhall model, door panels and trunk lids were produced on a monthly programme; they were transported from the press shop to a storage area to await further assembly. On the assumption that 300 units were produced every day, the storage space required was about 11,000 square feet and panels were sent to the assembly area for welding and metal finishing. Equipment required for this consisted of portable welding tools, assembly fixtures, projection welders and so forth, covering a floor space of 9,320 square feet and manned by 54 operators.

In contrast, with the new method the door assembly

line is a continuation of the press shop line, the panels passing directly from the presses in a continuous flow to the welding assembly line. This line consists of four press welding machines. It runs on a fortnightly cycle, and based on the same daily production as in the former case, a storage space of 14,400 sq. ft is required for complete assemblies. In addition to right and left hand front doors and right and left hand rear doors, the luggage trunk lid is also produced on the same line of machines; five changes of tooling are made during a fortnightly cycle, and during the idle period of two days each set of tools is inspected and serviced by the maintenance department ready for the next production run.

A very important point favouring this form of automation is the high quality of the finished product. Press welding results in a completely mechanical weld, independent of human skill, which is employed only for loading and starting the machine. If a machine has been set correctly, consistent welds of high quality are produced; where necessary, as in the case of door outer panels, welds can be obtained which require no metal finishing

Automatic Press Welding Machines

Two types of automatic press welding machines are installed at Luton; one is a four-pillar design known as the E.P.8, shown in Fig. 1, the other being an open-faced type described as the E.P.30. Both operate on the upstroke. The E.P.8 machine weighs about 12 tons and can withstand a maximum thrust of 30 tons between the faces when in the welding position. The lower part of each of the supporting columns has machined faces which form ways for the moving table. Motive power is provided by an electric motor of 10 horsepower mounted on the upper gantry of the machine, transmission being through a pneumatically operated plate clutch controlled by a solenoid, to a two-throw crankshaft. With each operation of the machine the crank makes one revolution, imparting an oscillating movement, through connecting rods and levers, to the countershafts on each side of the crown. At each end of these countershafts are other levers, attached through links, passing through the hollow pillars to the four corners of the moving table.

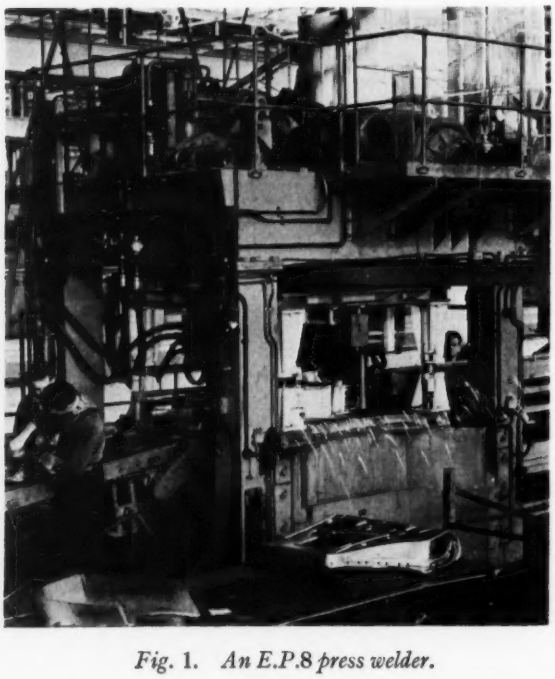


Fig. 1. An E.P.8 press welder.

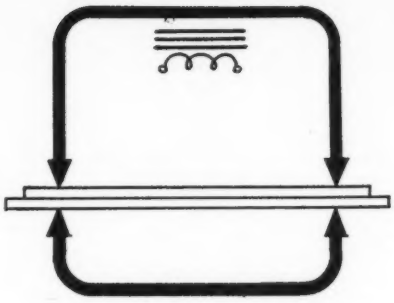
Each revolution of the crank moves these levers through a right angle—from a horizontal to a vertical position and back again—thereby raising and lowering the table 18 inches. Welding pressure is applied when the table is raised, with the levers in the vertical position, the table being locked during this part of the cycle. The face of the crown and moving table have a regular pattern of 1 in. tapped holes, for attaching the upper and lower halves of the press weld fixture to the machine. Each machine has a self-contained hydraulic unit for supplying pressure to the welding guns, comprising an hydraulic pump, hydraulic accumulator, solenoid-operated relief valves and change-over valves.

A group of cam switches is operated by the driving shaft, all controls being housed within a steel cubicle on the top of the machine. This includes Ignitron contactors, and an electronic timer for operating the welding sequence; this is in fact combined electronic and mechanical automation. Provision is also made for independently controlling the machine. A bank of push-buttons enables the maintenance operator to isolate the welding sequence, operate the hydraulic welding guns, and also to move the table very slowly upwards or downwards as required.

The problem of changing fixtures has been solved by fitting each machine with a pair of loading rails mounted on the crown face, the loading and unloading of the fixtures being done by a 5 ton Baker fork-lift truck. The operating principle of the E.P.30 closely resembles that of the E.P.8 machine, although their capacities and construction vary widely. The E.P.30 is an open-faced machine weighing about 6 tons, capable of withstanding a maximum pressure of 5 tons between the upper face and the moving table, which has a stroke of 8 in. This is a small machine in comparison with the E.P.8, but it is applicable to a wide variety of components.

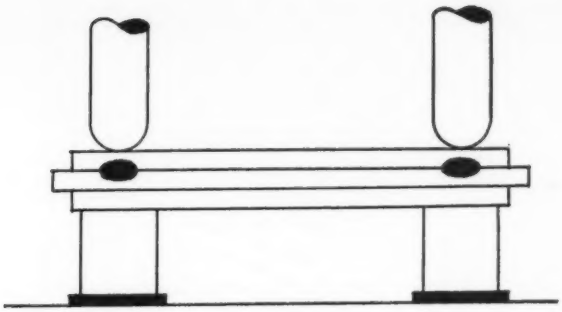
The series welding technique is generally used for press-welding where the thickness of the metal allows; where more than two sheets of metal 0·049 in. thick have to be welded together, direct spot welding must be employed. In series welding, as shown in Fig. 2a, two spot welds are produced in series; when it is desired that no weld marks should appear on a door assembly, for example, indirect series welding must be used. Here the current is shunted laterally across the panels, entering by one electrode and leaving by the other, producing a good spot weld between the two panels, as shown in Fig. 2b.

For welding heavier sections it is necessary to use direct welding, in order to employ a standard size of transformer. In this case a single spot weld is produced by the current from any one transformer secondary, the return circuit being completed by a knife switch;



A

Fig. 2a. Series welding.



B

Fig. 2b. Indirect series welding.

this kind of welding can only be employed when spot welds are near the edge or close to the aperture of a panel. Experience has proved that this is necessary in order to keep down the inductance of the current loop. When closely pitched spot welds are required on sheet material of heavy gauge, what is known as the "over-and-under" method of welding is used.

Fixtures inserted in a press welding machine consist of upper electrodes attached to the crown of the press and lower electrodes mounted on the moving table. The upper half of the fixture is generally made up of a fabricated steel framework on which are mounted the hydraulic cylinders providing welding pressure, the transformers for supplying the welding current and the oil manifold for delivering oil under pressure to the welding cylinders; the electrode tips and the transformer secondaries are cooled by a water circuit. The lower half of each fixture has a main base carrying the backing electrodes and locations for holding the components in position, correctly related one to another during the welding operation.

Before a fixture can be designed, considerable preliminary layout work is essential, undertaken by the press weld layout section, the members of which prepare layouts and weld studies of all the operations required to build a given assembly. From the component assembly drawing a weld study is worked out for each operation, which indicates the number and position of spot welds, with full operating instructions. Accessibility is vitally important where press welding is concerned, because it must be possible to replace any components used on a fixture, with minimum loss of time, all separate parts being positioned in such a manner that this can be done with ease and speed by the maintenance department. Since production depends upon the ease and speed with which the operator can manoeuvre a component in and out of a machine, this aspect of the work must be carefully considered.

Hydraulic pressure in a press welder can be adjusted to between 150 and 350 lb per sq in., depending upon the pressure ratio in the piston accumulator and the setting of the air pressure reducing valve. Heavier metal thicknesses obviously demand a higher welding pressure, and since the pressure is in most cases constant, the area of the piston and of the cylinder must be increased to cater for this extra thickness. Direct welding requires about twice as much pressure as series welding. In those cases where the close spacing of spots does not allow the size of the cylinders to be increased, greater hydraulic pressure can be produced by suitable adjustment of the pressure system.

The welding transformer is another very important item. This equipment must be compact and of minimum practical size, yet with adequate capacity to provide for every welding condition likely to be encountered in this type of work. A transformer of American design, with a current rating of 30 kVA, at 50 per cent duty cycle, measuring 14 in. long by $7\frac{1}{4}$ in. by $9\frac{3}{4}$ in. has been standardised for use in press welders. This apparatus is constructed of Hypersil C type cores, instead of the stamped laminations normally used in orthodox construction. The cores are manufactured from cold rolled steel which, when magnetised in the direction of rolling, has very good magnetic properties; the magnetic flux density is about 17,000 lines per sq. cm, with a guaranteed maximum loss of 1 watt per pound at a frequency of 50 c/s. This compares very favourably with 11,000 lines per sq. cm for ordinary transformer sheet steel. In other words, by employing C-type cores, the overall size of a transformer can be reduced by about 30 per cent.

Welding Controller

Further reduction in size is achieved by employing a simple primary winding with no provision for controlling the primary current, the latter being adjusted by the auto-transformer in the control panel. The output side of the transformer consists of two single-turn water-cooled secondary coils, each capable of producing two series welds or one direct weld. A maximum of five transformers may be fired simultaneously from a single Ignitron contactor. Since the transformers do not have individual heat controls, it is essential that the impedance of each transformer secondary loop must be balanced to ensure that the same current shall flow through each spot. Each group of transformers is brought in by one of the seven cams of the timing panel; with five transformers in each group, three groups, and four spot welds done by each trans-

former, a total of 60 series welds can be made with each stroke of the welding press.

Welding speeds of 300 or more assemblies per hour are attained, and it is clear that very little time is therefore available for loading and unloading of panels by the operators. Location holes in the component must be as large as conditions will allow, and the design of all locating pins should therefore be such that the operator can position the panels with minimum trouble.

The hydraulic pressure is a very important feature of this process. It is fed to the welding guns through a steel manifold, comprising a "feed" and "return" line bolted to the fixture. Oil supply to individual guns is taken through steel tubes, tapped off from the manifold at suitable points. A similar manifold is provided for carrying the cooling water to the electrode holders and transformers, the individual connections being made with flexible rubber hose. For the electrical power supply, a junction box containing one, two or three pairs of terminals is mounted in a suitable position on the press welding fixture, the number of terminals being determined by the number of groups of transformers required. Pyrotenax cable is used for connections between the junction box and the transformers, which is more adaptable to this type of installation, where adequate space is a problem. Connections between the fixture and the press weld machines consist of flexible rubber hose for the water supply, Lockheed flexible hydraulic hose for the oil, and rubber sheathed flexible cable for the welding current.

The sketch (Fig. 3) shows the circuit diagram of welding sequence control, and helps to explain the degree of automation achieved by this process. There is a number of individual sequences for each press welder, and these occur in the following order. The motor control circuit is energised by push-button and the table of the machine is raised to the welding position; the table having reached this position, the hydraulic controls are actuated to establish welding pressure at the welding guns. This pressure established, the welding timer fires the Ignitron contactors in progressive sequence; after the last contactor has fired, hydraulic controls remove pressure from the welding guns. Finally, when this pressure has been removed, and the welding electrodes have returned, the table is lowered to the open position ready for the next welding cycle. These operations are mainly straightforward mechanical movements caused by electric motors and solenoid valves controlled by relays, with the exception of weld timing, achieved by Ignitron contactors.

Hydraulic pressure is applied to the welding guns, and as soon as correct welding pressure has been attained, a pressure switch in the hydraulic circuit brings the electronic timer into operation. Relays fire No. 1 Ignitron contactor and its associated group of transformers for a preset number of cycles. After this predetermined period has passed, No. 1 contactor is released and the power supply to the first group of transformers is interrupted. On fixtures where two groups of welding transformers are used they fire consecutively.

It should be emphasised here that these machines and their equipment are costly, and are justified only where quantity production on a large scale is undertaken. Nevertheless, the basic principles of press welding are applicable to a wide variety of sheet metal assemblies, and are not by any means confined to car body construction. The method has several outstanding advantages. Spot welded assemblies can be produced with consistent accuracy at an hourly output rate of 300 or even more, with the added benefit that manufacturing floor space can be reduced by about 60 per cent of what was formerly required. Furthermore, experience has proved that the labour force can be reduced by as much as 55 per cent. Owing to the ideal conditions under which the equipment works in this case, there is considerable economy in the service life of jumper cables and electrode tips.

The first welding operation having been completed, the assembly is ejected from the fixture by a pneumatically operated ram and pushed on to the conveyor for transfer to the next machine. At the second machine, an E.P.30, 10 spot welds are made to seal the hinge assembly; the inner panel assembly is completed at the third machine, on which 12 welds are made, some for welding in the trim retainer panel and others are strengthening welds for the flange. At this stage the inner panel assembly is ready for fabrication to the outer panel assembly. After the final press operation on the outer panel, a sound deadener panel is applied.

The outer and inner panels meet at a clinching fixture, pneumatically operated and electrically controlled. The outer panel is first located in the fixture, the inner panel assembly being fitted into it so that the outer panel can be lightly clinched over the inner panel flange to hold the two panels together until they are welded. From this clinching fixture the assembly is conveyed to an E.P.8 press welder where welding takes place around flanges. From this machine the assembly is ejected on to a conveyor for transfer to a hemming press.

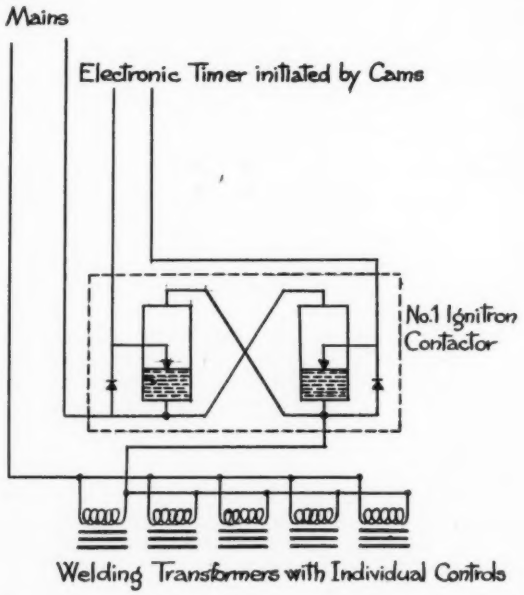


Fig. 3. Circuit diagram of welding sequence control.

The door hem is turned and flattened in the hemming press. A pneumatically operated roller ejector, fitted with composition rollers to prevent damage to the surface of the door, is incorporated in the hemming die. The door assembly is then complete. Complete door assemblies are hung in pairs on an overhead conveyor for transfer to a storage area and subsequent issue to the body building section.

It is very important to realise that press welding can be carried out efficiently only if the press work is undertaken to a high standard of accuracy, because steady output can be maintained only if the various pressings can easily be located in the fixtures and removed with equal facility on completion of welding. Furthermore, the finished sub-assembly must be accurate so that steady output can be maintained in the body building section. In order to ensure that such accuracy is being maintained, sub-assemblies are checked from time to time in an acceptance fixture.

The press lines in the new body building shop are extremely impressive, and here automation has been applied in a very effective and practical way. As soon as a blank steel sheet is loaded into the first press of a line, a simple electro-pneumatic switch triggers off all the subsequent operations which follow automatically in correct sequence to the end of a line. Pneumatically operated iron hands ease and accelerate the production processes, and a very important feature of press equipment is the clearing automation limit switch; the presses are of British Clearing type, made under licence in Great Britain by Vickers-Armstrong (Engineers) Ltd.

Clearing Limit Switch

This limit switch has the great virtue that it can be adjusted within exceptionally fine timing limits with the press in operation. The sketch (Fig. 4) shows the switch arm in a position parallel to the mounting surface which is the mid-point of its range of adjustment. Rough setting is made simply by rotating the cam from this starting point, fine adjustment being made with the thumbscrew while the press operates. The switch is mounted on a cast base which leaves all working parts readily accessible for adjustment and servicing.

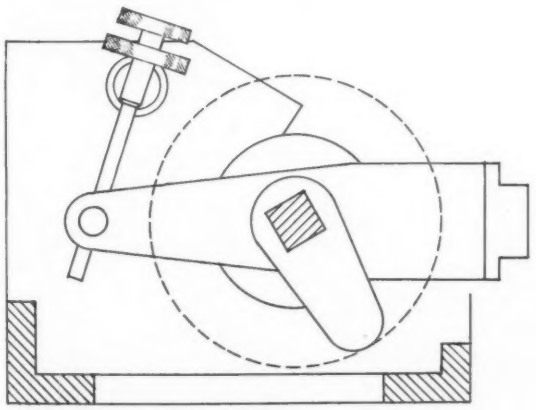


Fig. 4. Clearing limit switch.

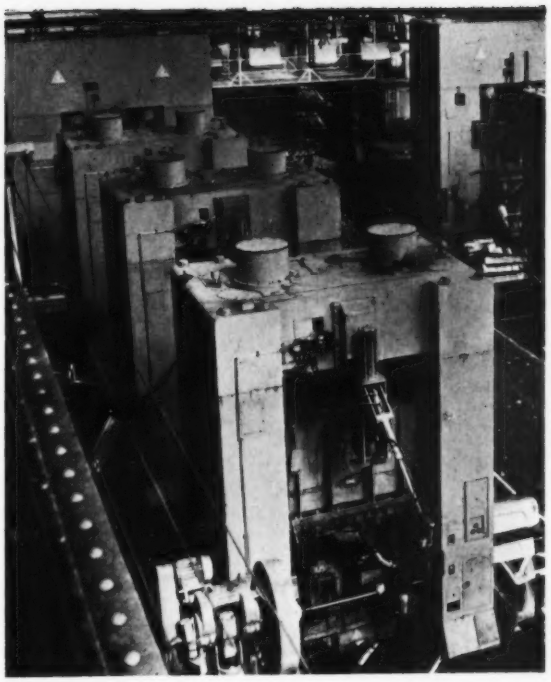


Fig. 5. Lines of presses.

Working parts are made of bronze or of steel plated with cadmium and the camshaft is mounted on steel ball bearings, the switch arms pivoting on oil-impregnated bushings. The whole switch mechanism is housed within a dust-tight and oil-free compartment built into the press frame to prevent mechanical damage and to keep all working parts in a clean and workable condition. Heavy duty power take-off mechanisms are provided to ensure precise synchronisation with the press motion.

Pre-adjustment of the cams is made with the equipment stationary, making certain that the press slide is stopped at a convenient reference position, such as the top stroke. All thumbscrews are then set at the centre of their range of adjustment, the point where all switch arms are parallel to the mounting wall. The cams are then unlocked by loosening a large nut on the camshaft just beneath the bottom switch arm, all cams being then free to move individually; there is no tendency for one cam to rotate adjacent cams inadvertently. All elements on the shaft are held in position by their own weight and by the weight of elements on top of them while adjustment is being made. When all adjustments have been made by moving the cams to their follower arms, the shaft nut is tightened and all cams are locked to the shaft. Fig. 5 shows the presses in action.

Fine adjustment is made while the press operates. The large thumbscrews are clearly marked to identify them with the press functions which they control.

(*Part II will appear next month.*)

ANALOGUE COMPUTERS

Part 3

By R. E. Hare, A.M.Brit.I.R.E. and W. E. Willison, Grad.I.E.E.*

5.0 APPLICATIONS

5.1. Solution of Linear Differential Equations

As an introduction to the application of the analogue computer it is instructive to consider the methods used to solve a simple second order differential equation with constant coefficients. In practice, of course, a computer would hardly be necessary for such a simple problem, unless perhaps a family of a hundred or so solutions were required; it will however illustrate the methods used, which are equally applicable to more extensive problems.

Consider the equation:

$$\frac{d^2x}{dt^2} + A\frac{dx}{dt} + Bx = O \qquad \ldots\ldots\ldots\ldots (1)$$

with initial conditions

$$\frac{d^2x}{dt^2} = O; \frac{dx}{dt} = O; x = x_o \text{ at } t = O$$

The first step is to rearrange the equations, solving for the highest derivative, and to simplify the operations, the operator $p = \frac{d}{dt}$ will be used thus:

$$p^2x = -\left[A\,px + Bx \right] \qquad \ldots\ldots\ldots\ldots (2)$$

The computer or machine equation should now be established by selecting scale factors and substituting in equation (2). Thus let $x = a_xX$ and $t = a_tT$ so that $p^2 = \frac{1}{a_t^2}P^2$ and $p = \frac{1}{a_t}P$; on substituting these relationships in equation (2) the machine equation is obtained

$$\frac{a_xP^2X}{a_t^2} = -\left[\frac{Aa_xPX}{a_t} + Ba_xX\right]$$

It will be seen that the amplitude scale factor can be cancelled out, but it will however affect the initial conditions. If a real time scale is selected, i.e., $a_t = 1$ the machine equation becomes:—

$$P^2X = -\left[APX + BX \right]$$

Applying the amplitude scale factor to the initial condition, $x_o = a_xX_o \quad \therefore X_o = \frac{x_o}{a_x}$

Fig. 33 shows the arrangement used for establishing the machine equation. A voltage proportional to P^2X is assumed to exist. This is integrated by amplifier 1 giving $-PX$ as its output; this is integrated by amplifier 2 giving the machine variable X as its output. The term $-APX$ is sign reversed by amplifier 3, and this output is summed with BX in amplifier 4. The output of amplifier 4 is P^2X, and this point may now be connected to the input of amplifier 1. If a voltage X_o is applied as an initial condition to amplifier 2, the desired relationship will be established.

When the integrators are started, the voltages will vary in a manner defined by the equation and if the voltage at the output of amplifier 2 is recorded the problem solution will be obtained. It should be remembered that this voltage must be multiplied by the scale factor a_x to give the actual solution.

5.2. Simultaneous Differential Equations

Consider the equations:

$$F_1(p)Y_1 + F_2(p)Y_2 = F_3(t) \qquad \ldots\ldots\ldots\ldots (1)$$

$$f_1(p)Y_1 + f_2(p)Y_2 = f_3(t) \qquad \ldots\ldots\ldots\ldots (2)$$

These equations may be written as

$$F_1(p)Y_1 = F_3(t) - F_2(p)Y_2 \qquad \ldots\ldots\ldots\ldots (3)$$

$$f_2(p)Y_2 = f_3(t) - f_1(p)Y_1 \qquad \ldots\ldots\ldots\ldots (4)$$

The right-hand sides of equations (3) and (4) are used as forcing functions, equation (3) being solved for $Y_1(t)$ and simultaneously equation (4) is solved for $Y_2(t)$, the systems being cross connected. As an

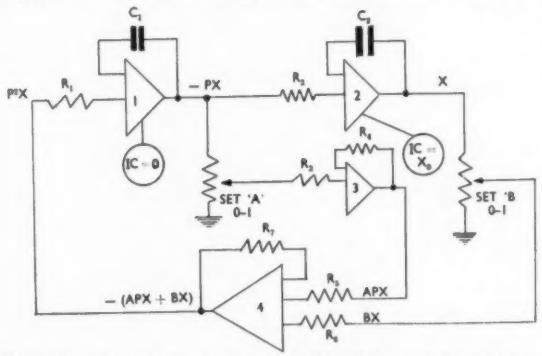


Fig. 33. Set-up for a second order differential equation.

*Analogue Computing Division, Elliott Brothers (London) Ltd.

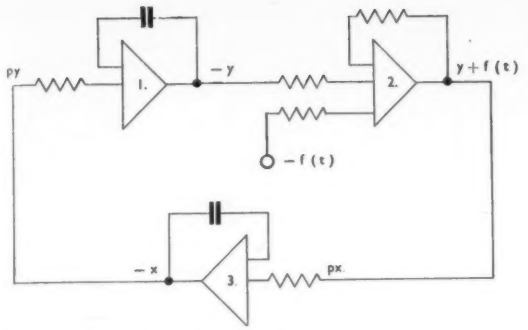


Fig. 34. Set-up for simple simultaneous equations.

example, consider the simple equations:

$$px - y = f(t)$$

and $$py + x = o$$

These may be written as:

$$px = f(t)\ ty$$

and $$py = -x$$

Fig. 34 shows the computing arrangement used which involves two integrators and an adder. It will be seen that $y + f(t)$ is used as the input to amplifier 3 and $-x$ as the input to amplifier 1. The application to more complicated systems will follow easily from equations (3) and (4).

5.3. Simulation of Complicated Transfer Functions

The operational amplifier can be used in conjunction with suitable passive networks to provide a very wide range of complicated transfer functions. If the assumption of the virtual earth is accepted, transfer functions can be easily obtained from the relation:

$$\frac{E_o}{E_i} = -\frac{Z_o}{Z_i}$$

Suppose that a transfer function of the form:

$A\left[\frac{1 + pT_1}{1 + pT_2}\right]$ was to be simulated, where A is a constant and T_1 and T_2 are time constants. Consider the arrangement shown in Fig. 35:

$$Z_o = \frac{\frac{R_2}{pC_2}}{R_2 + \frac{1}{pC_2}} = \frac{R_2}{1 + pR_2C_2} \quad \text{and}$$

$$Zi = \frac{\frac{R_1}{pC_1}}{R_1 + \frac{1}{pC_1}} = \frac{R_1}{1 + pR_1C_1}$$

Therefore

$$\frac{E_o}{E_i} = -\frac{\frac{R_2}{p + pR_2C_2}}{\frac{R_1}{1 + pR_1C_1}} = -\frac{R_2}{R_1}\left[\frac{1 + pR_1C_1}{1 + pR_2C_2}\right]$$

This expression is of the desired form and if the values of the passive components are selected such that $\frac{R_2}{R_1} = A$, $R_1C_1 = T_1$ and $R_2C_2 = T_2$, then the desired transfer function has been simulated.

As an example, if $A = 10$, $T_1 = 0{\cdot}2$ sec, and $T_2 = 0{\cdot}5$ sec, then $\frac{R_2}{R_1} = 10$. Choose $R_2 = 10$ M ohms, and $R_1 = 1$ M ohm.

$$T_1 = R_1C_1 = 1 \times 10^6 \times C_1 = 0{\cdot}2$$

$$\therefore C_1 = 0{\cdot}2 \times 10^{-6} = 0{\cdot}2\ \mu F$$

$$T_2 = R_2C_2 = 10 \times 10^6 \times C_2 = 0{\cdot}5$$

$$\therefore C_2 = \frac{0{\cdot}5}{10^7} = 0{\cdot}05\ \mu F$$

Provided the open loop gain of the amplifier is very large this approach may be used for obtaining very complicated transfer functions.

5.4. Fields of Application

The tabulation of all the possible applications of analogue techniques would be an extensive and time consuming project. This section will therefore be confined to a discussion of the major fields of application; some of the different types of problem that are encountered will be given, together with an indication of the most suitable type of computer for each class of problem.

(a) Study of Closed Loop Control Systems

The analogue computer is ideally suited to the study of closed loop control systems, particularly where non-linearities are involved. If the equations of the system are known, the problem may be tackled by using differential analyser techniques for which the different types of active computer may be used. So often it happens that the system equations may not be fully understood, but it is possible to break the system down into a series of block transfer functions; in such a case the convenience of the D.C. electronic computer, with its ability to simulate simple and complicated transfer functions by means of operational amplifiers is clearly of value. Furthermore, the real time type of computer enables parts of the real system to be included. The response of the control system to different types of input may be easily determined; of particular interest will be the response to step and sinusoidal inputs. The behaviour of a system in the presence of noise may also be assessed by the use of a noise generator. The ease

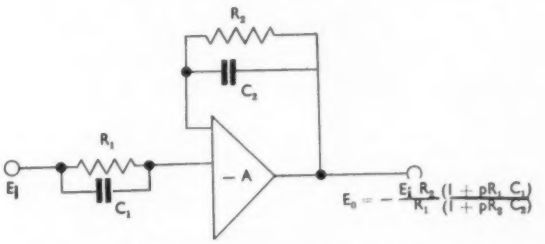


Fig. 35. Set-up for a complicated transfer function.

with which coefficients may be adjusted and the effect on the performance of the system observed enables a rapid determination of optimum conditions. It will be readily appreciated that this type of problem may arise in many of the different branches of engineering in which feedback techniques are used. The computer is not really concerned about the type of system it is to simulate; it can be purely hydraulic, purely electrical or a combination of the two, or for that matter any other type of system.

(b) Solution of Partial Differential Equations

Partial differential equations arise in many branches of engineering and physics and the analogue computer can be of great assistance in their solution. Most analogue methods are based upon the method of finite differences; by expressing the derivatives with respect to all but one variable as finite differences, a set of ordinary differential equations in terms of the remaining variable will result. The method of the finite differences has been extensively used in passive analogues for the solution of equations such as the Laplace and Poisson equations and general field equations.

The D.C. electronic computer has also been used for the solution of partial differential equations, particularly in problems concerning the vibration of beams and structures and in heat transfer studies. More detailed information may be obtained by reference to "Analog Methods in Computation and Simulation" by Walter W. Soroka.

(c) Simultaneous Algebraic Equations

Analogue computers have been used for the solution of sets of algebraic equations; the most successful devices have been either mechanical or passive electrical systems. The D.C. electronic type of computer has been applied to algebraic equations, but in general is less suitable than the other methods because of the difficulty of ensuring amplifier stability under varying feedback conditions. Methods of stabilisation have been evolved and are described in the various literature [11], [12] but for most large systems of equations, digital techniques are more easily applied.

(d) Examples of Particular Applications

Analogue computers are finding applications in many new fields in addition to assisting in the better understanding of problems in the older branches of science and engineering. The ability of the computer to handle non-linear relationships offers exciting prospects to many engineers who in the past have had to base their work upon assumptions and approximate methods.

One of the newest branches of engineering is probably that of nuclear power and analogue computers are being used for a variety of problems which arise in reactor design and applications. Simulators are also of considerable value for the training of reactor operators. Analogue techniques have been used to study the power build-up in a pile, to assess control rod stability, and to study such effects as xenon poisoning to mention but a few of the problems [13], [14].

Economists are finding the analogue computer of value in problems such as the stabilisation of capital, and other economic problems may prove suitable for analogue solution.

The following list of applications, whilst incomplete, will give some indication of the versatility of the analogue computer.

Aircraft control systems; automatic pilots; undercarriages; fuel systems; vibration and flutter problems; supersonic flow problems; study of missile guidance systems; flight simulation and ballistic trajectory calculations. Heat transfer in boilers; analysis of electrical rotating machines; transmission lines and distribution systems; analysis of linear and non-linear circuits. Car suspensions; carburation; hydraulic braking systems. Speed control systems; general servo mechanisms; process control systems.

6.0 CONCLUSIONS

6.1. Benefits of Analogue Techniques

The analogue computer has provided engineers, physicists and mathematicians with a valuable design aid. The ease with which complicated systems may be simulated has eliminated much of the arduous work from the solution of difficult equations arising from complex mechanisms; problems which in the past were left unsolved due to the sheer bulk of computation may now be handled in a reasonable time. Equations which once could only be solved by approximate methods may now be completely solved by non-linear analogue computers. The savings obtained by the elimination of costly trials by the use of analogue computers for partial system testing and preliminary investigations of systems will be self-apparent.

6.2. Type of Personnel Required for Computer Operation

Analogue computers may be successfully used by widely differing types of operators; once the basic principles of the art have been acquired, together with an appreciation of the errors involved, experience will do the rest. The D.C. electronic computer is probably the most widely used type, and whilst a background in electronic theory will be helpful it is not essential for the successful use of the computer. However, the increasing use of this type of computer has given rise to a new breed of engineer—those with a strong mathematical background. It is probably true to say that the computer has assisted mathematicians in obtaining a better understanding of engineering problems and has strengthened the mathematical ability of many engineers.

6.3. Future Possibilities

The future offers a challenge to computer designers; there is an ever-increasing requirement for computational aids to handle the vast problems arising in many fields of scientific endeavour. Higher and higher orders of accuracy are demanded, and in many cases this is provided by high speed digital computers, which are programmed after exploratory work has been carried out using analogue methods. Very high accuracies are not feasible with present analogue machines, mainly due to the prohibitive cost; the trend in the analogue field is therefore directed towards cheaper and more

flexible computers with the acceptance of limited accuracy. In many cases an accuracy of say $\pm 1\%$ is acceptable and the speed advantage of the analogue computer more than offsets this limited accuracy.

New advances in electronic components and semiconductor devices will be applied to analogue devices, and a small desk computer, capable of handling linear and non-linear equations, is becoming a practical proposition. Such a machine may one day be found on every engineer's and mathematician's desk in place of the present desk calculators.

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Symposium on "The Mechanisation of Thought Processes"

THIS symposium was held at the National Physical Laboratory on 24th November, and was attended by over 200 of the foremost scientists in this field. The symposium provided a view of the scope offered by machines which can learn by experience, and gave an idea of some of the difficulties which must be overcome before application of this type of machine becomes a commercial possibility.

The programme of the symposium covered the general principles of the mechanisation of thought processes, automatic programming, language translation, speech recognition, learning in machines and implications in biology and industry. In any field of development, the solution of one problem often serves to create or reveal another. In the development of electronic computers, the problem of computing and data processing at high speeds has to a large extent been solved, but the need now remains for programming and coding the problems. It seems that the difficulty of preparing programmes may prove a bottleneck to realising many promising potential applications of computers. If machines were available which had incorporated in them devices whose mode of operation was not specified initially, but which learnt from experience what to do, then these machines would be able to do jobs which had not been fully analysed because of their complexity.

Work is in progress on the design and programming of machines to work on problems for which the designer does not have, in advance, practical methods of solution. Attention is being given to processes involving pattern recognition, learning, planning ahead, and the use of analogies or "models". In the field of business and industrial management a computer could conceivably play a large part in making policy decisions: taking into account a great many relevant facts and combining them with a much greater degree of perfection than normal people can. It may seem an ambitious step to try to apply mechanisation or automation to the legal sciences. However, a machine for processing information could be an effective aid in searching for sources for legal information, in developing legal arguments, in preparing the decision of the administrator or judge, and finally in checking the coherence of solutions arrived at. The stumbling block in these applications would be the production of a programme embodying the rules for making the appropriate deductions from a great variety of facts.

The next step must be to attack the problem of automatic programming, when the computer can be relied on to specify the runs of a problem in an optimum manner, design the data layouts, and in general behave like the "electronic brain" it has so often been called. Ability to code rapidly and without errors should accelerate programmes in data retrieval, language translation and many other problems awaiting computer solution. Considerable advances have been made in the field of machines capable of recognising visual signals. With the development of character reading machines and of larger stores, language translation will be limited only by the ability to write programmes defining the translation process.

It seems likely that learning machines will play a part in such projects, the automatic recognition of speech and of visual patterns, and in automatic control where it is often virtually impossible to analyse an industrial process completely from first principles.

THE INSTRUMENTATION AND CONTROL OF A STOCK PREPARATION PLANT

The plant—see Fig. 1—supplies paper stock at the desired consistency and composition to the machine wire. The plant is at the Reed Paper Group's Empire Paper Mills.

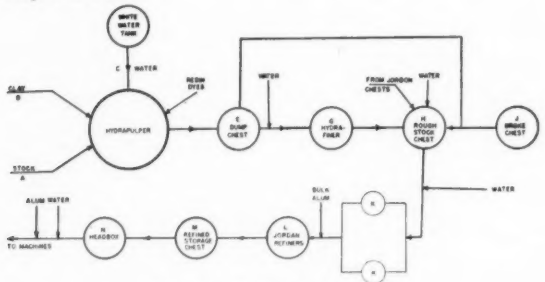


Fig. 1. *Paper stock plant.*

The baled pulp is fed in batches by a conveyor (A) to a hydrapulper (B), where it is agitated with water (C) and a china clay slurry (D) to form a rough stock. Starch and dyes are also added here. Batches of rough stock from the hydrapulper are stored in a dump chest (E) in which an agitator is rotated to prevent stock de-watering. Any broke (J) is returned from the machine to this point. The rough stock is then mixed with a regulated quantity of water (F) through the medium of a consistency controller and, in this way, stock of the desired consistency passes forward to the hydrafiners (G) whence, after initial de-fibring, it is pumped into the rough stock chest (H).

After leaving this rough chest (H) the stock is diluted with water by a second consistency controller.

Two large unrefined chests (K) provide a large capacity and ensure a steady supply of stock to the Jordan refiners before which bulk alum is added (L), from which the stock is transferred to the refined stock chest (M).

The refined stock is then pumped to the machine headbox (N), and between the refined stock chest and the headbox the final consistency controller adds water to ensure that the stock leaving the plant is at the desired consistency.

A pH recorder-controller measures and controls the pH after the headbox, the alum solution control medium being admitted at the mixing pump inlet.

Each of the chests, with the exception of the dump and broke chests, is provided with level controllers which regulate the stock supply and, in addition, each chest has a low level detector and a low level alarm signal light. The low level alarm is connected to a central alarm system and is also arranged to stop any out-going pumps under this condition. Similarly, the high level alarm automatically stops the stock input pumps.

A further refinement ensures that stock plugging cannot occur, this being done by making the instrument system automatically shut any nearly-closed valve: this state of affairs is continued until such time as the relevant control valve is called, by the instrument circuit, to have a wider open position than a certain pre-set minimum opening.

The hydrafiner and refiner protection systems provide that on low flow, or stoppage of the stock supply pumps, the plugs are withdrawn immediately and the hydrafiners and/or refiners shut down with the pump(s), if the pump(s) have not already stopped, after a pre-set time delay. The individual hydrafiners and refiners have a low pressure alarm protection device which withdraws the individually affected plug(s) immediately, and stops the stock supply pump(s) after a suitable time delay. The usual "inch-in", "inch-out", "run-out", "start", "stop" and "reset" push-buttons are provided for each hydrafiner and refiner, the operation of which can be assessed from the kW recorders mounted on the control panel.

The more important off-normal conditions give rise to both audible and visual alarms within and on the panel. Acknowledgment of the alarm fault cancels the audible alarm and the previously flashing alarm light becomes steady until the fault is cleared.

The equipment was supplied by Electroflo Meters Co. Ltd.

ELECTRONIC CONTROL INSTRUMENTS

Increased use of electronic instruments for the purposes of controlling variables, such as temperature, and the flow of liquids, has resulted in the design in Australia of a control unit with wide applications.

The unit, which uses transistors instead of valves, was invented by Mr. R. H. Riordan, of the Engineering Section of the Australian Commonwealth Scientific and Industrial Research Organisation.

A feature of the circuit design is that the controller will continue to function satisfactorily even if slight changes take place in the performance of individual parts.

The accuracy of control will be maintained as long as certain components do not change. In normal use these few critical parts should remain stable almost indefinitely.

The new instrument has proved very satisfactory for controlling the supply of electric current to a heater, so as to maintain a desired temperature.

It is applied also to the control of refrigeration and is readily applicable to a wide range of industrial operations.

PHYSICAL SOCIETY EXHIBITION PREVIEW

The following is a preview of the equipment which will be displayed and demonstrated. It is not complete but represents the latest information at the time of going to press.

Admiralty Research Establishments **Stand No. 37**

The Admiralty Research Laboratory will be exhibiting an automatic strain gauge balance equipment which was designed for use with resistance strain gauges for force and pressure measurements in hydrodynamic research.

A film assessor will be shown which provides a semi-automatic means of measuring accurately on photographic records positional co-ordinates and orientation. It has been designed primarily to produce information on standard five hole teleprinter tape (or punched card) for feeding into a high speed computer. Although originally for analysis of cine records it is applicable to the analysis of kine-theodolite records and also continuous trace records. Miniature radioactive contamination meters developed for ship-borne use in case of an atomic explosion, using transistors and with self-contained power supplies, will also be shown.

The Admiralty Signal and Radar Establishment will be showing a sealed ammonia filled resonant cavity for use as a portable microwave frequency standard; a constant beamwidth S-band horn type aerial; a microwave artificial dielectric lens manufactured from a newly developed low loss artificial dielectric; and a metre-wave radar aerial.

The Services Electronics Research Laboratory have developed a X-band C.W. power travelling wave tube which uses a "cloverleaf" type of structure and combines good power handling capacity with moderate band width. A section model will be shown illustrating the construction, together with typical performance curves.

A parametric amplifier for the microwave region will be shown as a working exhibit together with examples of the solid state devices used for obtaining the reactance variation.

Advance Components Ltd. **Stand No. 31**

Airmec Ltd. **Stand No. 40**

Associated Electrical Industries Ltd. **Stand No. 146**

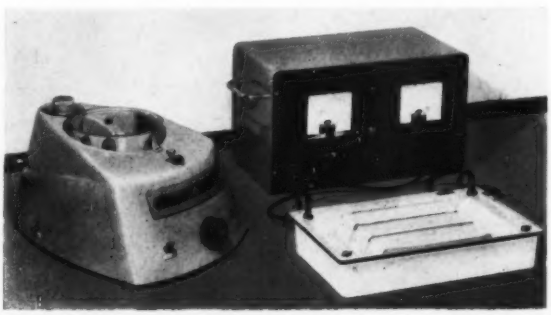
The following optical instruments define straight lines, and have been developed for engineering purposes.

1. The Rodolite. This consists of a plane reflection grating (2 in. diameter) ruled with a system of concentric circles. The line defined optically is the normal to the grating through the centre of the circles. The intersection of this line with planes perpendicular to it is found by a sensing head. The Rodolite has been used for testing the ways of lathes in relation to the axis of rotation of the head stock and the ways of hobbing machines in relation to the axis of rotation of their tables. It is also a suitable instrument for checking the truth of large surface plates, and aligning bearings.

2. Straight line interferometer. This instrument consists of two identical concave mirrors mounted at either end of a tube about 18 in. long. The centre of curvature of each mirror lies on the surface of the other, and the optical line is that joining the two centres of curvature. The position of the line is sensed by a Wollaston prism which produces white light fringes in the focal plane of the viewing telescope. The instrument measures profiles of surfaces up to 15 in. long with an accuracy to $\pm 0{\cdot}15$ μ in.

3. Double-ended alignment device. The Rodolite, or alignment telescopes, when working at large distances (e.g., 20 ft) are extremely sensitive to tilt. By using two optical systems to define each end of the line this disadvantage can be overcome. The double-ended device has two such systems which are set up at the extremities of the line.

4. Crystal pulling equipment. This apparatus has been designed to eliminate the conventional heated crucible for holding the melt. Crystals are pulled from a pool of melt formed in the parent solid material which rests on a water-cooled hearth.



B.T.L. equipment for electrophoresis; densitometer, stabilised power unit, horizontal tank.

Avo Ltd. **Stand No. 131**

Baird & Tatlock (London) Ltd. **Stand No. 98**

The range of equipment for paper chromatography will include a strip tank, multi-sheet tank, two dimensional sheet tank, stoneware tanks, all glass spray, drying oven and desalting apparatus.

Columns and a fraction collector for column chromatography will be shown, and the horizontal tank, a constant current/constant voltage stabilised power unit and a densitometer for electrophoresis.

Prototypes will be exhibited of a gas chromatograph and a centrifugal chromatograph.

Baker, C., of Holborn Ltd. **Stand No. 91**

Two models of the new low stereoscopic magnifiers for laboratory and workshop use are available.

1. The Trilux microscope condenser is now in production in a modified form. It enables light field, dark field and phase contrast to be done with one condenser and a rapid changeover to be made from one illumination to another.

2. The Simplux illuminator is an inexpensive illuminator which can be fitted to student microscopes in place of the mirror. It provides sufficient light for oil immersion work.

3. The 3 min polarising microscope has been redesigned and will be shown for the first time in its new form.

4. The interference microscope is shown with the cell compressor designed by Dr. Ambrose, of the Chester Beatty Research Institute.

5. A Series 4 research microscope will be shown, equipped with objectives using a new design of mount.

Baldwin Instrument Co. Ltd. "Atomat" beta ray thickness gauge with operator remote control unit.

Baldwin Instrument Co. Ltd. **Stand No. 38**

The company will be showing a range of their "Atomat" equipment, of which the following are included:

1. Backscatter thickness gauge. The electronics of this equipment are identical to those used in the standard transmission gauge. Only one side of the material to be measured need be available, the only stipulation is that the other side of the material should be backed with a substance having a substantially different density and atomic number.

2. Fast responding "Atomat". This equipment is applicable for the automatic thickness control of products produced on high speed machines such as metal foil rolling mills. The maximum speed of response is of the order of 0·04 sec.

3. Nucleonic thickness gauge with automatic standardisation. This is a standard beta gauge to which has been added a new type of standardising unit designed to maintain the measuring instrument in close accuracy.

4. Transverse profiler. This is a bench version of the beta ray substance gauge intended primarily for use in the paper industry for the measurement of level.

Barr & Stroud Ltd. **Stand No. 61**

Beck, R. & J. Ltd. **Stand No. 93**

The "Multimax" stereoscopic binocular microscope exhibited last year is now available with interchangeable stands, a large table support being shown.

The "Optomax" research binocular microscope is shown equipped with a universal vertical illuminator. The alternative lens systems incorporated in the unit provide for vertical illumination by either the light-field or dark-field techniques.

1. Integral substage illuminator. In order to satisfy modern requirements, an integral illuminator, fitting interchangeably with the substage mirror of the No. 47 range of microscopes is introduced.

2. Vertical illuminator. This illuminator supersedes the Wrighton-Beck unit for routine light-field vertical illumination.

3. "Versalite" microscope lamp. This lamp supersedes the "Intensity" lamp and by utilising a prefocus 6 V 15 watt lamp, alignment for Köhler illumination conditions is readily achieved.

4. Simple micrometer microscope. The microscope unit, fitted with rack and pinion focusing, accepts all standard microscope optics and by means of a special objective can be readily converted into a simple telescope.

5. Bier contact lens spherometer. This adaptation of a standard microscope unit enables the curvature of either positive or negative surfaces not exceeding 10 mm radius to be measured to an accuracy of 0·01 mm.

Bellingham & Stanley Ltd. **Stand No. 115**

Bristol, University of **Stand No. 58**

A differential capacitance manometer, designed to be part of a pneumotachometer which is not yet finished, has had considerable use for finger plethysmography. The transducer consists of a stressed beryllium copper diaphragm 0·002 in. thick and 1·5 in. in diameter between two brass plates. The output of the apparatus is registered on a built-in valve voltmeter and can also be connected to a standard ink-writing device. A demonstration will be given. A modification of the Grey Walter toposcope for single channel electroencephalographic display, using a standard two-channel C.R.O. and electroencephalographic amplifier, demonstrates inherent rhythmicity in the E.E.G. output over a 10-second period, and the time relationship of the E.G. rhythm to any stimulus.

British Physical Laboratories **Stand No. 28**

British Physical Laboratories will be showing examples of their developments in electronic test equipment.

1. The electronic engine tester, Model EET Mk. I, enables a detailed check to be made of the ignition circuit of an internal combustion engine. The tin plate thickness meter utilises the change in inductance and Q value of a coil when that coil is brought near a ferrous material. In the application to be shown, the ferrous material is coated with tin plate. The 100 kc/s component comparator, Model Cz.457/1, has been specifically designed for the testing of condensers, resistances and inductors under mass production conditions.

2. A digital voltmeter, Model DV.1058, is designed to give a three digit display on an in-line numerical read-out display up to 99·9 millivolts d.c. in steps of 100 microvolts. A wide band amplifier, Model WA.1152, which was originally designed for the

R. & J. Beck Ltd. "Multimax" stereoscopic binocular microscope.

army has now been accepted by them as a standard piece of equipment.

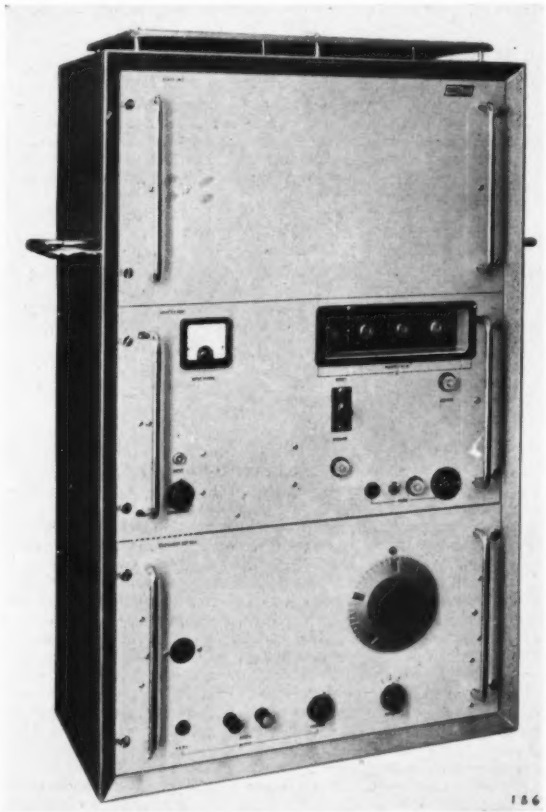
3. The universal impedance bridge, Model UB.202 Mk. IV, covers a wide range of measurements for values of resistance, inductance and capacity. The resistance voltage coefficient measuring set, Model RV.258, has been designed to overcome the difficulties in complying with the test measurements stipulated in RCS.112 entitled "Specification for resistors' fixed composition".

British Scientific Instrument Research Association **Stand No. 53**

Work at B.S.I.R.A. has been directed towards a knowledge and control of the structure in the initial stages of the growth of thin films. Some of the apparatus used in connection with this project includes: apparatus for measuring the interfacial energy between condensed atoms and a substrate; apparatus for measuring the difference in binding energies between gold in the aggregated and non-aggregated states; apparatus for observing the effect of surface conditions on the electrical resistance of gold films. This apparatus will be exhibited together with some examples of applications to instruments.

A modification of the Smith Chart has been devised for the purpose of computing the transmission characteristics of non-absorbing optical or electrical multi-element filters. The conventional printed chart is replaced by a system of mechanical linkages together with a spiral computing element.

Some new applications of pneumatics to instruments will be exhibited. A conventional ring balance is mounted on an air bearing which, acting as a journal, also has means for taking up end thrust due to small degrees of out-of-level of the instrument. The instrument shown has a full-scale deflection for a differential pressure of 4 mm w.g. and sufficient power to write directly on a chart.



Cawkell Research and Electronics Ltd. damping constant meter, Type LDA.

In the pneumatic level gauge being shown only an extremely small degree of tilt is required to cause ejection of a spindle from a horizontally disposed air bearing housing. By this means it is estimated that surfaces can be set level with an error not greater than $\pm 30''$ of arc.

A pneumatically-guided depth-indicating float assists in determining the level of water in hydraulic models when the actuating force is limited by the size of the float and when cross-currents give the float a bias loading in one or other preferred direction. In the models shown, two pneumatically operated journal-guides serve to prevent contact between the float stem and its housings and thus reduce frictional forces to almost negligible proportions.

British Thomson-Houston Co. Ltd. **Stand No. 49**

Through recent improvements in their brightness and light maintenance, electroluminescent panels are now practical light sources for information display. Complex panels with shaped electrodes representing electrical, mechanical, hydraulic or other elements are used to depict the mode of operation of complicated production processes.

The electrostatic dust monitor demonstrates a method of measuring dust concentration in a gas stream, being applied to the measurement of fine dust in power stations.

Built around a rotary standing wave detector, the admittance plotter is designed to display automatically, in a few seconds, the admittance of waveguide components over a broad frequency band. The superheterodyne centimetre spectrometer is intended primarily for the analysis of the spectra of pulsed oscillators, by displaying on a cathode ray tube the frequency distribution of the R.F. power. The range of pulse width is 0·1 microseconds to 5 microseconds. The I.F. noise generator is a unit capable of generating "white" noise over the normal range of I.F. frequencies. The diode anode current is variable between 50 μA and 20 mA and is completely independent of both fast and slow fluctuations in the supply.

The "helisyn" position control is still undergoing development. This device is for the purpose of precision linear mechanical positioning in response to a numerical input.

Experimental versions of silicon controlled rectifiers will be shown and demonstrated and recent developments in silicon transistors will be exhibited.

Burndept Ltd. **Stand No. 5**

The following instruments will be exhibited:—

1. Automation instruments:

Electronic production counter	BE.244
Carton contents monitor	BE.251
Press output counter	BE.250
Proximity switch	BE.238

Probes for use with proximity switch include:—
Standard probe, temperature control probes, moisture control probes, level control probes, liquid level probes, and a further variety to suit any particular problem.

2. Laboratory instruments:

Capacitive transducer indicator	BE.245
Transistorised power supply unit	BE.253
Digital valve voltmeter	BE.246

3. Nucleonic instruments:

Portable contamination monitor	BN.116
Radiation monitor ratemeter	BN.110
Fast neutron monitor	1407C
Pocket Geiger counter	BN.118

Nucleonic thickness gauge.

Cambridge Instrument Co. Ltd. **Stand No. 106**

The company will be demonstrating a Transrite Cardiograph Mk. II and a display incorporating preferred pointer position. An automatic chart analyser which "samples" a recorder chart at intervals of one millimetre will be shown together with a mains unit with intrinsically safe output, a dissolved oxygen analyser (gas-phase transfer type), and a general-purpose polarograph.

Cawkell Research & Electronics Ltd. **Stand No. 16**

Two new oscilloscopes will be displayed for the first time.

The two-channel oscilloscope, Type TC1, uses a double-gun cathode ray tube for the display of two different signals. A common time-base generator is employed but separate amplifiers are fitted.

The transient storage oscilloscope, Type SO1, is designed for the visual study of transient phenomena. The E702 has an image-storage system which enables the user to retain a single signal for examination for up to ten minutes.

The non-destructive testing equipment exhibited will include the density gauge, Type DG1. This is a transistorised portable unit for measuring the density of substances *in situ*. A radioactive source of gamma radiation is used and the level of radiation is measured at a fixed distance away by means of a Geiger counter. Future developments of this instrument provide for a modification to allow the moisture content of the medium to be measured. Adequate precautions to protect the operator are taken in the design of the apparatus.

A new model of the LDA damping constant meter has been produced. Particular modifications provide for measurements at lower (down to 50 c/s) and higher (up to 50 kc/s) frequencies, for novel methods of excitation of the specimen and for simpler operation.

The impulse materials tester, Type IMT1, produces a pulse signal in the material by means of a hammer blow and then measures the rate of propagation in the material. It is particularly suited for the testing of road surfaces and aircraft runways.

Chance-Pilkington Optical Works **Stand No. 79**
Pilkington Bros. Ltd.

C.N.S. Instruments Ltd. **Stand No. 36**

The firm will be exhibiting the following equipment:

1. Mechanical rotary analogue to digital converter. In this device the analogue movement is applied to a shaft carrying a disc which is opposed to suitably positioned micro-switches. When at rest the disc and micro-switches are brought together causing the operation of the appropriate micro-switches. These are in turn connected to the solenoids of an electric typewriter.

2. Eddy current tube tester for non-ferrous metals. This equipment is designed to locate defects in non-ferrous metal tubes. High frequency search coils, either external or internal, are balanced against a standard section of the tube and then passed through or around the tube to be tested. When a fault is located both audible and visual alarm signals are given.

Cooke, Troughton & Simms Ltd. **Stand No. 99**

Cossor Instruments Ltd. **Stand No. 22**

The amplifiers being exhibited include a laboratory high-gain l.f. amplifier, Model 1442, suitable for voltage amplification in the frequency range 5 c/s to 3 kc/s, a wide-band amplifier, Model 1439, for television and v.h.f. radio distribution systems, and a directly coupled pre-amplifier, Model 1440, for use in cascade with a further amplifier or with a recording device. A 6 V transistorised power unit, Model 1326, a laboratory power unit, Model 1328, for use as a power source for transistor equipment and a battery eliminator, Model 1327, designed primarily to power the Cossor pre-amplifiers, will be shown.

Oscillograph Model 1039M, Mk. II, is the smallest in the Cossor oscillograph range and weighs 10¼ lb. Single and double beam oscillograph and Telecheck and marker generators will also be on view. The Model 1046 millimicrosecond pulse generator is suitable as a test source for distributed amplifiers and is applicable to nuclear physics instrumentation where its fast rise-time is suitable for the testing of circuits associated with high-speed counters. Cameras which have been developed specially for use with Cossor oscillographs will also be shown. Cossor will also be showing a transistor tester, an ultrasonic test set, a salinometer, and a six-way transducer unit for use with the Hydrodyne, Model 1063: this instrument can be used to display, analyse and measure pressure conditions in all hydraulic and pneumatic systems.

Croydon Precision Instrument Co. **Stand No. 124**

Crystal Structures Ltd. **Stand No. 4**

The Wooster automatic recording microdensitometer Mark II is a more compact instrument than the original model, all the electronics being housed beneath the carriage, the rotation of the light shutter providing the necessary cooling. Two lead-screws at right-angles permit automatic traverses to be made in perpendicular directions. The largest films likely to be used by crystallographers—28·5 cm × 12·5 cm can be accommodated on the carriage.

The automatic line-seeker is designed to find automatically the centre of an X-ray reflection which may extend over a small angle or over a range of several degrees.

Dawe Instruments Ltd. **Stand No. 128**

The Dawe exhibit will include pulse generators, oscillators, frequency meters, ultrasonic generators, stroboscopes and noise level meters. Further details are given below.

The Type 304 impedance comparator is designed for production line testing of resistors, capacitors and inductors.

The range of oscillators exhibited will include a fully transistorised battery-operated oscillator Type 421, which gives continuously variable frequency coverage over the range 20 c/s and 20 kc/s in three decade stops.

The Type 614C sensitive valve voltmeter has been designed to replace the current Type 614B instrument. The voltage range has been increased by a factor of 100 times (10 times in each direction) to permit voltage measurements from 80 V to 300 V at frequencies between 5 c/s and 100 kc/s. The input resistance has been increased from 1 megohm to 10 megohms to minimise loading when making measurements in high impedance circuits. A direct reading transistorised frequency meter, used in conjunction with the Type 716 transistor photo-electric pick-up, provides a means of measuring rotational shaft speeds without imposing any load on the machine under test. Up to a maximum of 1,800,000 rev/min can be measured, which is beyond the rotational velocity of any practical machine.

A transistor photo-electric pick-up designed to trigger a Type 1200 stroboscope in synchronisation with a rotating mechanism. It will also operate the frequency meter Type 715.

Type 1156 250 W Soniclean generator, the smallest ultrasonic generator in the Soniclean range will drive one Type 1160/T24 self-contained stainless steel tank transducer or one Type 1161/B18 immersible stainless steel transducer. The Type 1204 high intensity stroboscope employs four separate hand lamp units with a maximum flash rate of 6,000 flashes per minute.

A portable battery-operated transistor stroboscope can be used for the viewing and speed measurement of rotating machines in locations where a mains supply is not available. It is designed for the measurement of speeds over a range 600 to 15,000 rev/min in two steps, the flashing rate is indicated directly on a meter.

The Type 1405 objective noise meter has been designed for use in application where a greater accuracy is required than can be achieved with the Type 1400 sound level meter and also in high sound fields and under conditions of extreme vibration such as are found in aircraft.

The acoustic calibrator Type 1411B has been specifically designed to check the calibration of the objective noise meter Type 1405 which uses the S.T.C. Type 4021 J microphone.

Type 1418 transistor sound level meter is a transistor battery-operated sound level meter: the use of transistors virtually eliminates circuit microphony.

Decca Radar Ltd. **Stand No. 23**

Six Grade 1 microwave attenuators covering the frequency band 1,700-18,000 Mc/s and designed to make accurate attenuation measurements will be exhibited.

The recently developed WG 8 Grade 1 test equipment is representative of a wide range of Grade 1 instruments available in five waveguide sizes. With the standing wave meter it is possible to make VSWR measurements to better than 0·5%, guide wavelength measurements to better than 0·2% and the carriage position is indicated to ±0·05 mm over a range of travel of 34 cm. A complete noise factor test set is included in a portable case. The measurement is made to an accuracy of ±0·5 dB by means of an I.F. attenuator calibrated directly in noise factor. No calibration curves or R.F. attenuators are required. Special examples of electro-formed components such as junctions, couplers, rotating joints, switches and transformers will be exhibited to demonstrate the latest techniques of electro-forming.

A wide range of attenuating elements for standard rectangular waveguides will be shown. Resistive discs for coaxial-line systems will also be shown, together with a new and compact form of low-power load for rectangular waveguides.

Department of Scientific and Industrial Research **Stand No. 47**

Mechanical Engineering Research Laboratory. An automatic weighbeam has been developed for the precise measurement of steady pressure or forces. A model will demonstrate dynamic measurement to the order of 0·001 in. of relative movements of the position of a shaft within a bush.

The British Steel Castings Research Association. A slide-rule calculator which has been developed for the rapid calculation of exposure times in gamma radiography will be exhibited.

Hydraulics Research Station. A demonstration will be given of a low pass filter which separates the wanted signal of 0·02 c/s from the wave signal of 0·2 c/s.

British Cast Iron Research Association. A demonstration will be given of a high frequency dielectric heating equipment and testing unit designed to obtain the properties of moulding sand at elevated temperatures.

Road Research Laboratory. A working model will be shown of a device for recording axle loads of fast moving traffic. Pressure membrane apparatus and headlamp alignment apparatus will also be shown.

Building Research Station. A new X-ray technique for high temperatures will be demonstrated.

Low Temperature Research Station. A simple electromagnetic valve for the control of gas flow will be exhibited.

D.S.I.R. & Fire Offices' Committee Joint Fire Research Organisation. Their exhibits will consist of a thermal radiation dose meter and a simple anemometer.

National Physical Laboratory. A demonstration will be given of an imitation of learning by a conditional probability computer. The ACE computer will be exhibited. Other demonstrations will include a technique for the measurement of displacement, a sphericity interferometer, and an electrical extensometer for creep strain measurements.

Radio Research Station. A recording microwave refractometer will be demonstrated.

Distillers Co. Ltd. **Stand No. 50**

Three types of automatically-functioning equipment will be displayed.

D.C.L. null balance magnetic oxygen analyser. This instrument has been developed for the analysis of oxygen in any mixture of common gases such as flue gas, inert atmospheres and gas process streams. It measures the magnetic susceptibility of a continuously flowing sample, using a feed-back system. The instrument will be shown with the new ultra-rapid D.C.L. multipoint gas sampling panel, which enables gas to be taken from any one of a number of sample lines simply by inserting a bayonet plug into the appropriate socket.

D.C.L. panoramic temperature display unit. This instrument displays on a cathode ray tube the temperature distribution in a chemical reactor or other thermal system.

D.C.L. metering pumps. The D.C.L. range of variable capacity pumps has been developed for the accurate metering of small quantities of fluids, in connection with distillation processes, antibiotic research, catalyst injection, water treatment and similar operations where constant pre-set flows are a requirement.

Dobbie McInnes (Electronics) Ltd. **Stand No. 127**

Two types of trace analysis equipment will be shown. In the first (TRA) the measurement is made as a resistance analogue, then sealed electrically and passed to an analogue/digital converter before applying to a punching or tabulating unit. In the second type (TRD) the reading cursor operates a digitiser which, after decoding, directly operates the punch or tabulator. The overall accuracy is of the order of 1 part in 1,000 and readings can be maintained at speeds of one every two seconds.

The various units such as decoders and impulse counters with visual displays and serial output for typewriters, etc., are also supplied as separate self-contained units.

An analogue/digital converter is a new addition to the firm's range of instruments. This unit is designed to convert d.c. analogue voltage levels to decimal digits with sign with a resolution of 1 part in 999.

Doran Instrument Co. Ltd. **Stand No. 117**

A new form of automatic titration apparatus will be shown, in which the indicator as well as the controlling equipment with the requisite relays, etc., are all mounted in a single case with the titration stand fitted on one side.

A precision general purpose d.c. potentiometer with internal reflecting galvanometer has three ranges of 1 microvolt to 18 millivolts, 10 microvolts to 180 millivolts and 100 microvolts to 1·8 volts. It has an accuracy of 0·02% of the maximum reading of the range in use. A pH test unit has been designed to provide input voltages for checking pH meters and high impedance potentiometers using an electrometer valve. The accuracy of the applied voltage is to within ±0·1% and resistances of 100 megohms and 1,000 megohms can be introduced for determining the grid current of the instrument under test.

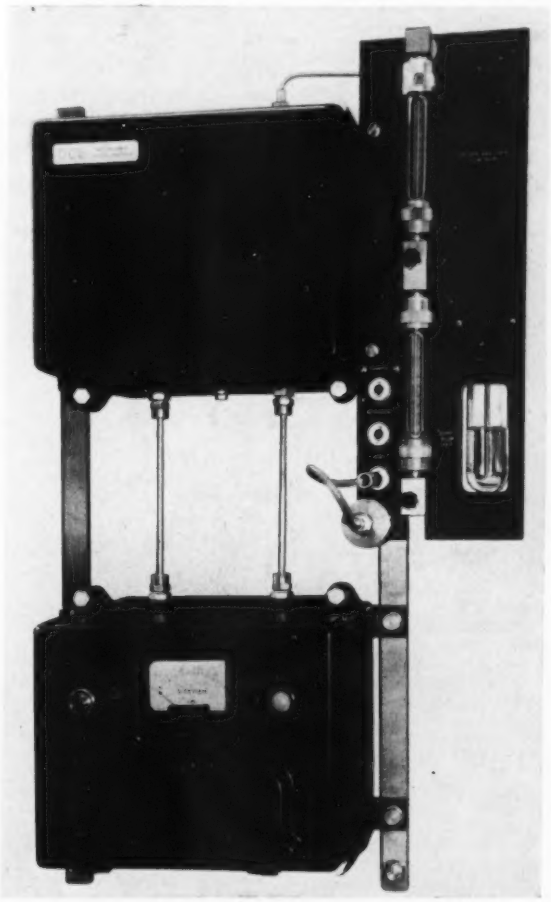
Also on view will be a mini thermocouple potentiometer, a portable Wheatstone bridge comprising a four dial decade resistance box having a total resistance of 11,110 ohms with ratio arms to give ratios of 0·001, 0·01, 0·1, 1, 10, 100 and 1,000 and a vernier potentiometer which has three-dials giving readings from 10 microvolts to 1·89999 volts with an accuracy of the order of one part in 100,000 of the 1 volt setting.

Dynatron Radio Ltd. **Stand No. 134**

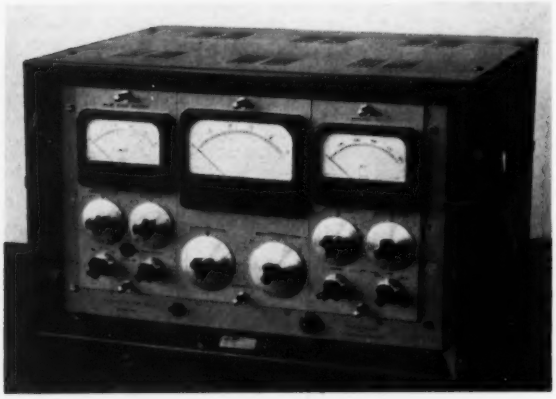
Dynatron will be displaying and demonstrating their latest nucleonic instrumentation. Being exhibited for the first time is a prototype Dynatron nucleonic test set.

Another prototype being shown for the first time is the transistorised pulse amplifier and power supply for use with proportional counters designed for use in slow neutron counting. Its specific application is for soil density and moisture content measurements.

The scaler unit 1009E with a counting speed of 2,500/sec is



D.C.L. oxygen analyser.



Ekco Type N600 ratemeter.

designed to count random or regular electrical pulses of amplitude greater than a predetermined value, which may be set between +5 and +50 V.

The essential function of the power unit N.104/5 is to provide a source of stabilised e.h.t. for G.M. tubes and ionisation chambers.

The highly stabilised power unit N.103 will supply the high voltage needed by most types of counters used in nuclear physics, especially scintillation counters and other proportional counters where extreme stability is required.

The coincidence unit 1036C contains a three channel coincidence circuit. Facilities are provided within the unit for amplitude discrimination, variable paralysis time and variable delay time.

Edwards High Vacuum Ltd. **Stand No. 149**

The latest developments in rotary high vacuum pumps, ultra high vacuum equipment, vacuum measuring instruments, leak detection equipment, vacuum coating plant and metallurgical and distillation plant will be exhibited.

An automatic large-scale pumping system with liquid gas transfer equipment will be shown. Examples of vacuum coating will include metal film resistors, infra-red reflectors and aluminised cathode ray tubes.

Ekco Electronics Ltd. **Stand No. 39**

Ekco exhibits will comprise a selection of recently-developed nucleonic instruments for use in the fields of medicine, industry, research and reactor instrumentation.

1. Scintillation counters. Type N559F scintillation counter measures alpha activity on a filter paper by means of a zinc-sulphide phosphor on a 1·5 mg/cm² screen in place of a crystal. A clinical scintillation counter, Type N618B, provides improved collimation and shielding.

Type N612 liquid scintillation counter is shown counting carbon 14 in a liquid phosphor. It is also suitable for counting tritium (when refrigerated to −20°C) which is particularly valuable in body water measurement.

2. Ratemeters. Type N600 ratemeter incorporates a complete spectrum analysis facility in a discriminator unit which has an automatically or manually swept single channel.

3. Radiation monitors. Type N596 beta-gamma survey meter is a new portable radiation monitor designed to meet the requirements of the impending Factories Act for beta and gamma radiation. Ranges of 0-3, 0-30 and 0-300 millirads/hour are provided together with an integration facility up to 30 millirads.

Type N645 universal low activity monitor is a lightweight portable equipment for tracing very small quantities of any radioactive source.

4. Linear amplifier. Type N640 linear amplifier is a general-purpose, 1 Mc/s bandwidth amplifier with a cathode follower output.

5. Vibrating reed electrometer. The latest vibrating reed electrometer, Type N616, has high stability and has ranges of three millivolts to three volts at input resistances of 10^{8}, 10^{10} and 10^{12} ohms.

6. Reactor instruments. Type N638 log gamma monitor is a new reactor instrument comprising an air-wall ionisation chamber with amplifier head unit and a rack-mounting main amplifier connected together.

7. Aircraft transistor inverters. Two new transistor inverters are designed to replace rotating machines of equivalent power ratings.

8. X-Y plotter. This instrument provides, on a 10 in. × 7½ in. plotting area, a record of the inter-relationship of two variables fed to the instrument in the form of d.c. voltages. The response speed of the Y-axis is 1/5th sec d.c. for full-scale pen travel and the corresponding response speed of the X-axis is ½ sec. Sensitivity is variable from 1 mV/in. to 10 V/in. and the input impedance is greater than one megohm on both axes.

Electro Methods Ltd. **Stand No. 8**

Electronic Instruments Ltd. **Stand No. 132**

Electronic Tubes Ltd. **Stand No. 60**

Demonstrations will be given of the progress of cathode ray tube design, culminating in a new tube with increased deflection sensitivity, dual trace tubes, battery-operated tubes and a tube with a new type of screen phosphor.

Elliott Brothers (London) Ltd. **Stand No. 138**

E.M.I. Electronics Ltd. **Stand No. 122**

Engelhard Industries Ltd.—Baker Platinum Division **Stand No. 101**

The Baker integral-sheath thermocouple comprises a flexible metallic outer sheath, insulated from the central thermo-elements by means of a pure oxide refractory powder. Corrosion-free, precious metal-clad thermocouple contacts with a low, stable contact resistance, for use in the measurement of fuel-element can temperatures will also be exhibited.

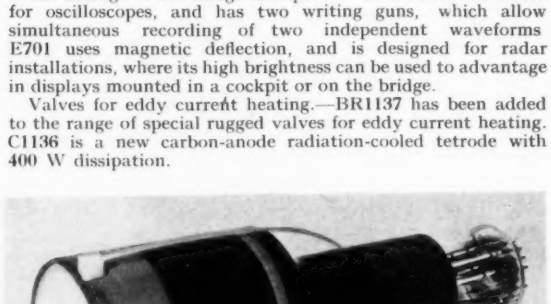
Recombination catalysts, for use with radiolytic gas and tail gas treatment, and gases for use to reduce the nitrogen oxide content of the fumes occurring in nitric acid production, will be shown.

An exhibit will demonstrate the Baker "Atomex" immersion gold solution method of applying a thin, dense, adherent coating of pure gold to a variety of metals without the use of electric current.

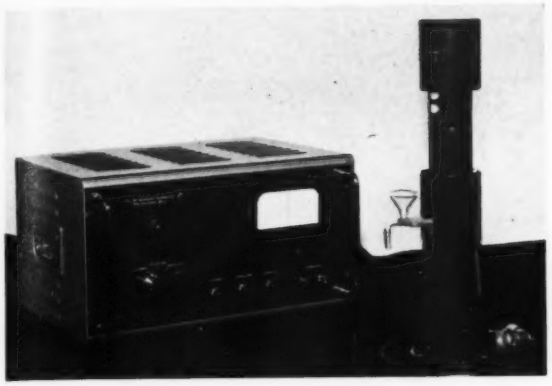
English Electric Valve Co. Ltd. **Stand No. 100**

Daylight viewing storage tubes.—E702 has electrostatic deflection, and is intended primarily for use in oscilloscopes where storage of the image is required. E703 is also intended for oscilloscopes, and has two writing guns, which allow simultaneous recording of two independent waveforms. E701 uses magnetic deflection, and is designed for radar installations, where its high brightness can be used to advantage in displays mounted in a cockpit or on the bridge.

Valves for eddy current heating.—BR1137 has been added to the range of special rugged valves for eddy current heating. C1136 is a new carbon-anode radiation-cooled tetrode with 400 W dissipation.



English Electric Valve Co. Ltd. E702 daylight direct viewing storage tube.



ETL-NPL automatic polarimeter, Type 143A.

Image intensifier orthicon.—P815 is an image intensifier orthicon used in X-radiography to reduce the intensity of X-radiation in diagnosis.

Germanium rectifiers.—VA710, VAW721 and VAW722 comprise a new range of germanium rectifiers, the largest diode being rated at about 250 A with suitable cooling conditions.

Magnetrons.—M567, a replacement for 2J42, is fitted with flying lead heater connections and a waveguide output. M564, a development from 7182 (M543) has a circular waveguide output and gives powers up to 3·5 MW in the range 2,750-2,860 Mc/s.

Klystrons.—K344 is a 10 kW klystron for scatter communication applications at frequencies around 800 Mc/s and has a gain of 33 dB. K347 is a three cavity pulsed klystron amplifier for the frequency range 575 to 625 Mc/s. K352 is an S-band pulsed klystron amplifier with a gain of not less than 30 dB and peak power outputs up to 6 kW.

Reflex klystrons.—K351 is a rugged reflex klystron oscillator for use under conditions of high mechanical stress. K353 is a reflex oscillator giving 200 mV output over the range 10,500 to 12,200 Mc/s, and is intended for use in apparatus for the measurement of velocity.

Travelling wave tubes.—The range of tubes for communications and radar purposes has been increased by the addition of three new tubes, N1031, N1032 and N1035. These are respectively low noise, intermediate and power output tubes for use in waveguide systems at 4,000 Mc/s. N1029 is a newly developed waveguide-mounted power output tube for use in the 7,000 Mc/s communications band. The gain is 20 dB and power output 5 W.

Backward wave oscillators.—N1010 (2,400 to 4,500 Mc/s) and N1034 (7,000 to 11,500 Mc/s) are wide range voltage tuned oscillators giving outputs greater than 20 mW over their operating band.

Ericsson Telephones Ltd. **Stand No. 97**

One of the most recent developments on show will be the industrial batch counter, Type 165A, which has been designed specifically for use with positive displacement flowmeters to facilitate the dispensing of accurate quantities of liquid, and which may also be used for any other process where predetermined quantities of discrete units or articles are required to be batched.

Another installation is the ETL-NPL automatic polarimeter, Type 143A, which has been based on an original design by the National Physical Laboratory.

Other exhibits include transistor counting and arithmetic units, unitised counting equipment, vibrating reed electrometer, punched tape preparation unit, digital ohmmeter, digital voltmeter, rotary motion pulse generator (Rotapulse), and bi-directional transistor counter with digital indicator. A comprehensive selection of electromagnetic devices and special tubes for counting, timing and control will also be exhibited.

Evans Electroselenium Ltd. **Stand No. 62**

Evans Electroselenium Ltd. will exhibit a wide range of "EEL" photo-electric instruments, including the "EEL" fluorimeter for the measurement of the fluorescence of liquids, the "EEL" titrator for complexiometric titrations, the "EEL" adjustable gloss head for the measurement of gloss throughout the range of 15-85 deg., and the "EEL" street lighting photometer for the assessment of light values.

New "EEL" multi-range galvanometers will also be exhibited: a d.c. millivoltmeter plus an oil-filled unit will be included among these. These taut suspension galvanometers are recent developments available to manufacturers for incorporation in a wide variety of instruments. The "Unigalvo", Type 35, is an example of the range of taut suspension galvanometers. It is a five range current or voltage instrument.

Fairey Aviation Co. Ltd. **Stand No. 139**

Ferranti Ltd. **Stand No. 46**

On show will be the latest types of silicon devices including fast diodes, alloy diodes and diffusion rectifiers with higher permissible reverse voltages, reference diodes for voltages between 3 and 10 volts and rectifiers for currents over 100 A.

Working exhibits will demonstrate the operation of two and three terminal switching diodes of the four-layer type, transistors, and solar cell units in which the photovoltaic effect is used to operate a switching device. Also exhibited will be samples showing the latest developments in silicon technology.

The display of ceramic-metal sealing techniques will include new production components involving ceramic-metal seals, high temperature seals to 100% alumina ceramics (1,250°C brazing temperature), copper disc seals, pin seals and large diameter compression seals to high alumina ceramics.

The klystron exhibits will include a range of X-band klystrons suitable for c.w. radar application and Type VA201B klystron made under licence to Varian Associates. This is an extremely rugged tunable low voltage reflex klystron of 50 milliwatts power output, covering the range 8,500-9,600 Mc/s.

Work has been proceeding with the development of a new photomicrographic flash tube and it is hoped to arrange a demonstration.

Industrial cathode ray tubes. Development of new tube types has continued throughout the year and a range of these will be shown in all sizes from 2½ in. round.

Ferranti diffraction grating measuring system.

The Ferranti transistorised tape reader TR7 has been designed for equipment such as electronic digital computers which require the input of information at high speed. This reader reads punched paper photoelectrically at speeds up to 1,000 characters per second. Five-, seven- or eight-track tape can be read. For the purposes of checking, each character is read twice.

The diffraction grating measuring system operates on the principle of photoelectric detection of Moiré fringe patterns and the conversion of these patterns into electrical impulses to actuate dekatron counters.

Digital voltmeters and ohmmeters will be shown, the latter being introduced for the first time.

Static inverters employing junction transistors in a switching mode, but giving a sinusoidal output will be shown. The conversion efficiency is 80% for 400 c/s units.

Wattless transistor regulators will be exhibited. These regulators employ one or more transistors in parallel acting as a switch in a circuit with a diode and choke condenser filter. Efficiencies of the order of 90% are obtained, and in a typical unit employing a simple circuit input voltage variation is reduced one hundred times.

The new version of the M.D.4 magnetic drum, designed for the Ferranti Pegasus computer, has an almost doubled storage capacity. The previous capacity was 5,120 42-bit words; it is now 9,216 words. These are held on 160 tracks, each track having a read/write head.

Flann Microwave Instruments Ltd. **Stand No. 2**

Fleming Radio (Developments) Ltd. **Stand No. 7**

Furzehill Laboratories Ltd. **Stand No. 14**

Two new oscilloscopes will be shown. The Type O.140 is a direct-coupled instrument covering a band width from d.c. to 10 Mc/s, with an input range of 5 mV to 500 V. A flat-ended 4-in. p.d.a. tube is used with a timebase, either recurrent or triggered, providing sweep speeds from 2 cm/sec to 10 cm/μ sec.

The second instrument (Type O.160) has been developed primarily for curve tracing. It has a 6-in. flat-ended tube with differential input on both axes with calibrated attenuators accurate to $\pm 2\%$.

A new logarithmic valve voltmeter known as the V.220 will be shown. This has a range of 10 mV to 100 V over the frequency range of 10 c/s to 5 Mc/s.

A precision R.C. oscillator, Type G.432, will be shown. This covers a frequency range of 25 c/s to 250 kc/s with an accuracy of $\pm 1\%$ together with an incremental dial which adds an accurately calibrated frequency increment at any part of the scale.

A range of standard tuning forks will also be displayed from simple transistor maintained forks delivering an output of the order of 1 V to valve-maintained forks with dividing and shaping circuits providing pulsed outputs of various characters.

The Type S.510 spectrum analyser will also be exhibited. This equipment provides a panoramic display on a 6-in. tube of the components of an a.m. or f.m. signal within the band 3 to 30 Mc/s.

Finally a demonstration will be given of a three-phase variable frequency supply. This equipment was originally developed for testing of speedometers and similar devices requiring a series of accurately known shaft speeds.

General Electric Co. Ltd. **Stand Nos. 25, 27**

General Radiological Ltd. **Stand No. 114**

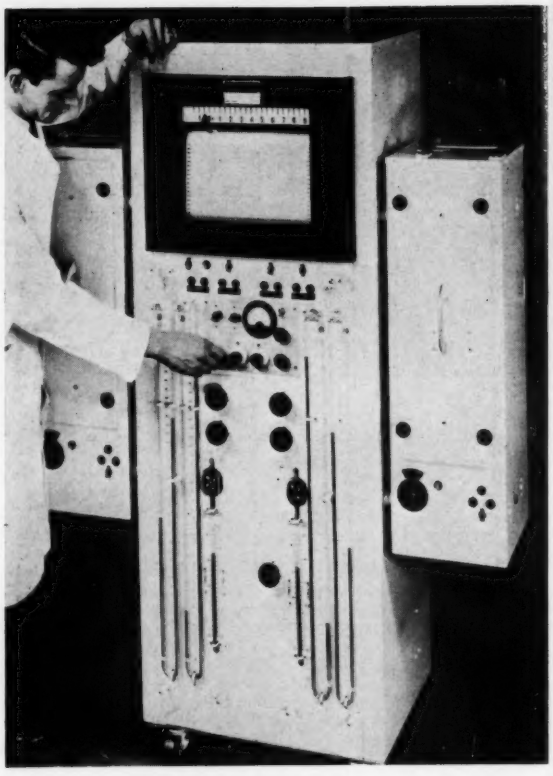
Griffin & George Ltd. **Stand No. 123**

The firm will be exhibiting the following instruments:

1. Griffin-Raleigh elution bridge. This instrument was designed primarily for monitoring washing processes in transistor production and in the electro-plating industry.

2. The Griffin panmetron bridge is a mains-operated instrument which serves as an a.c. bridge for comparing resistance and reactance at 50 cycles/sec using external standards, and also as a high gain detector amplifier for use with external bridge circuits.

3. Bateman's jet reaction apparatus demonstrates that force is proportional to the rate of change of momentum and enables a value for the acceleration due to gravity to be determined.



Griffin VPC apparatus, Mark 26.

4. The Griffin VPC apparatus, Mark 26, and Griffin-Raleigh water de-ioniser will also be on view.

Grubb, Sir Howard, Parsons & Co. Ltd. **Stand No. 63**

The exhibits will include a double beam grating infra-red spectrometer of simplified design which uses Merton-N.P.L. grating replicas. This instrument is an experimental prototype.

An infra-red gas analyser competitive with the Luft type of instrument but employing some dispersive system has obvious advantages. Such an analyser has now been completed and will be shown in use for simple analytical determinations.

An example will be shown of a simple plant control problem employing both a direct deflection infra-red gas analyser and a null-balance analyser.

A prototype infra-red gas analyser with pneumatic null-balance will be exhibited.

Multi-layer filters of the type shown by the National Research Development Corporation in 1957 are now in regular production and examples will be exhibited.

With a view to improving the performance of the standard sonic gas analyser, an effort has been made to increase the frequency from 3 or 4 kc/s, as now used, to much higher values, possibly as high as 1·6 Mc/s.

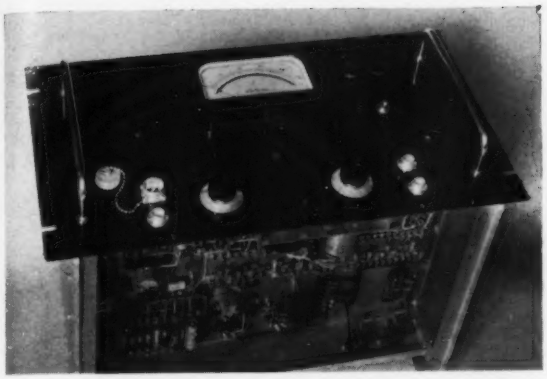
New difficulties appear with these high frequencies, and experiments which demonstrate some properties of ultrasonic waves in relation to the design of a gas analyser will be shown.

Hammersmith Hospital, Department of Physics **Stand No. 52**

Hatfield Instruments Ltd. **Stand No. 10**

Hilger & Watts Ltd. **Stand No. 125**

Hivolt Ltd. **Stand No. 105**



Isotope Developments Ltd. single channel pulse height analyser.

Imperial College, Mechanical Engineering Department **Stand No. 54**

Infra-red Development Co. Ltd. **Stand No. 87**

Among the components on show will be:

Variable and preset throttling valves capable of giving a fine control of gas flow rate at pressures up to 200 p.s.i., flow controllers to give a constant preset flow rate in the range 0·25 to 1·25 litres per minute with pressure drops varying between 40 and 300 mm Hg; pressure relief valves to operate at pressures as low as 2 in. water gauge; absolute pressure regulators to maintain the gas stream in a cell at a constant pre-determined pressure, and end of line and visi-filters and gauged piston tap assemblies.

Institute of Physics **Stand No. 43**

Isotope Developments Ltd. **Stand No. 136**

The instruments to be shown cover many industrial, medical and research applications and include the following:

1. Scaler, Type 1700. This incorporates a complete and automatic counting apparatus in a single table-top unit. It requires only the addition of a radiation detector to provide for any type of radioactivity measurement.

Incorporated in the scaler Type 1700 are a dekatron scaler and electronic timer (with facilities for "pre-set time" or "pre-set count" operation); a ratemeter; a single channel pulse height analyser; stabilised high voltage supply (up to 2,000 V); and a linear pulse amplifier.

The instrument may be utilised for remote start/stop operation. Provision is also made for connecting an external automatic print-out unit and for an external count rate recorder.

2. Diagnostic scintillation counter, Type 700. This instrument has good shielding and has interchangeable collimators to give a wide range in the directional characteristics of field or area.

3. Gammalarm, Type 656. The gammalarm is a simple, self-contained radiation monitor for wall mounting. It is used in radiotherapy departments, laboratories, irradiation facilities, and any areas where gamma radiation may occasionally exceed the normal background level.

4. Scintillation counter, Type 661. This employs a 1 in. diameter photomultiplier and is both compact and light in weight.

5. Single channel pulse height analyser, Type 672A. The improved version of this instrument incorporates a synchronous scanning motor to drive the channel sweep potentiometer.

6. Portable scintillation counter, Type 1413A. This instrument comprises a complete scintillation counting system operated from three standard torch cells. Its high gamma sensitivity makes it useful as an environmental survey meter, or in locations where small changes in the level of background radiation must be studied.

7. Beta gauge, Type 150. This is designed for the continuous measurement of thickness of all types of sheet or strip material.

Johnson, Matthey & Co. Ltd. **Stand No. 110**

Joyce & Optica Group **Stand No. 84**

Kelvin & Hughes Ltd. **Stand No. 120**

Labgear Ltd. **Stand No. 35**

Lintronic Ltd. **Stand No. 17**

Locarte Co. **Stand No. 82**

Lyons, Claude, Ltd. **Stand No. 135**

McArthur Microscopes Ltd. **Stand No. 92**

Medical Research Council Pneumoconiosis Research Unit **Stand No. 60a**

A size separating sampling instrument for airborne particles will be shown. Size distributions are determined by counting particles along strips across the deposit and multiplying by factors obtained by calibration using spherical particles. A nitrogen meter for the investigation of lung function and a double image microscope micrometer with facilities for accurate particle size analysis will also be shown.

The *Neuropsychiatric Research Unit* will be showing a time-multiplex oscilloscope for encephalography.

Megatron Ltd. **Stand No. 21**

A range of different shapes and sizes of mounted and unmounted selenium photo-cells with different spectral characteristics will be shown, including improved "potted" selenium cells, tropical, fast and resistant to chemical attack.

A selenium photo-cell transistor unit will be shown. The "potted" two pin units can be plugged into standard sockets and are suitable for photo-electric relay work, counting, etc. They are capable of delivering 6-8 mA at 15-20 V d.c. at illumination intensities of 10-20 ft candles.

Besides the well-known range of cosine corrected light meters C1-C3 and C5a, an integrating light meter developed in co-operation with National Institute of Agricultural Engineering will be shown.

Samples will be shown of three different types of coatings on glass which are being used on antistatic instrument windows and for de-misting and de-frosting, electroluminescence, etc.

Mervyn Instruments **Stand No. 118**

The Mervyn-WPRL wide bore polarographic electrode enables a continuously flowing liquid to be monitored by polarographic techniques, which are not conveniently achieved with the conventional dropping mercury electrode. In addition the particular design, which is due to the Water Pollution Research Laboratory, provides a constant current for a constant concentration of reducible ions in solution, and the magnitude of this current is considerably larger than that which would be obtained from a normal electrode.

The Mervyn-Harwell square wave polarograph Mark III incorporates all the features of previous models.

The Mervyn-Cerl sulphur dioxide recorder. This new instrument has been specially designed by the Central Electricity Research Laboratories for the analysis of sulphur dioxide in the atmosphere in concentrations down to 0·01 parts per million. The instrument operates continuously and the result is presented on a recorder chart.

The large area alpha scintillation counter has been designed specially for samples of low activity and has over twice the scanned area of any other counter.

This experimental low frequency tripping equipment was built in conjunction with the Transmission Design Branch of the Central Electricity Generating Board and consists of three suitably modified low frequency detectors together with auxiliary tripping relays. The equipment is intended for installation at unattended grid substations, so that in the event of abnormally low frequency, automatic load shedding may be accomplished in two stages. To avoid unnecessary disconnection of supply, it is arranged that at least two detector units must operate before any load shedding occurs.

Metropolitan-Vickers Electrical Co. Ltd. **Stand No. 147**

A prominent exhibit will be an X-ray microanalyser

which enables quantitative chemical analyses to be performed with small volumes (about 1 cubic micron) of material. This analyser was developed by the Associated Electrical Industries Research Laboratory at Aldermaston, and is the prototype of production models at present being constructed by Metropolitan-Vickers.

Three spectrometers will be on show. The first, a Type MS7 double-focusing mass spectrometer of the Mattauch type primarily for the analysis of impurities in solids; the second, a 2 in. radius laboratory mass spectrometer for use in those applications where it is necessary to determine directly the composition of gases and vapours in an apparatus without any intermediate sampling; and the third, a Newton-Victor "Raymax 60" X-ray fluorescence spectrometer.

Other exhibits will include a model of a vacuum system for Zeta, an ultra-high vacuum plant, high vacuum equipment, a peak-reading digital voltmeter, a periodic table of the isotopic abundance of the naturally occurring elements (this exhibit was devised for use in the International Hall of Science at the Brussels Exhibition) and charts and diagrams illustrating investigations into the degassing rates of various materials.

Ministry of Supply **Stand No. 1**

Muirhead & Co. Ltd. **Stand No. 107**

The Muirhead transfer function analyser will be demonstrated in connection with a model servo system.

The D-880-A 2 phase low frequency decade oscillator has a frequency of 0·01 c/s to 11·2 kc/s. Two outputs—90° apart—are available at a maximum level of 10 V.

The D-888-A high frequency analyser/oscillator can be used either as a sensitive, constant gain frequency analyser (with a Q-factor of not less than 70, an octave discrimination of 40 dB and a minimum indication of 50 microvolts) or as an oscillator (with an output level of 2·5 V into 500 ohms).

The D-788-B low frequency analyser has a frequency range of 3 c/s to 3 kc/s. The instrument includes a synchronous motor drive for the frequency dial—thus enabling an input frequency spectrum to be automatically scanned.

The D-936 transistor-maintained tuning fork frequency is normally 400 c/s but can be arranged to be any frequency up to at least 1,000 c/s. Latest developments have made possible the production of 60 c/s servomotors and motor tachometers in standard size 15 and 18 frames; these motors have high torque/inertia ratios and are also suitable for use on 50 c/s.

Miniature size 08 synchros will be exhibited with size 08 and size 10 servomotors and size 11 linvars.

Another recent development on show will be a size 11 gearhead specially designed for mounting in instrument servomechanisms and size 11 servomotors to Bureau of Ordnance, Society of Automotive Engineers and/or Royal Aircraft Establishment specifications.

Mullard Ltd. **Stand Nos. 141, 142**

Murex Ltd. **Stand No. 85**

Murex will be exhibiting examples of items fabricated in tantalum, niobium, tungsten, molybdenum and zirconium. These five metals are available in the form of rod, sheet and wire and can be fabricated by spinning, welding and machining. Condensers for hydrochloric acid plant, bayonet heaters and other items of corrosion resistant chemical plant fabricated in pure tantalum will be displayed. Internal units for high temperature furnaces are fabricated in tungsten and molybdenum and many items in these metals are made for the electronics industry.

A range of sintered permanent magnets will also be on view together with Sincomax composite magnets. Examples of the recently developed magnetic alloy Comalloy will be available. This alloy has the property of being sufficiently ductile to be machinable prior to final heat treatment. Sintered iron pole pieces will also be shown and are available for industry.

Nagard Ltd. **Stand No. 20**

Nash & Thompson Ltd. **Stand No. 15**

National Institute of Agricultural Engineering
Stand No. 55

National Research Development Corporation
Stand No. 144

New Electronic Products Ltd. **Stand No. 9**

Two basic types of galvanometer recorder will be shown. One of these uses the standard tungsten light source and photographic paper necessitating photographic processing before the trace is available. The other recorder has an ultra-violet light source and special print-out recording paper—in this instrument the trace is visible after a few seconds' exposure to ambient light.

A six-channel carrier amplifier recently developed will be exhibited. It comprises six independent amplifier and demodulator systems with a common power unit and oscillator. Provision is made for synchronising several units and tapping the oscillator if required.

A magnetic tape recorder will serve as an additional input-output store for computers. This instrument uses an eight-channel magnetostatic head which comprises both read and write units.

A double-pole, double-throw miniature relay, which is balanced against acceleration spin, will be exhibited. The operating time is 5 m/sec, and the operating power, 100 mW.

A range of differential inductance pressure transducers has been developed for continuous use at temperatures of 200°C. These are suitable for high differential temperatures between pressure inlets and for short period use at ambient temperatures of up to 250°C. The differential pressure range available extends from 0-5 lb/in² to 0-2,000 lb/in².

Newport Instruments (Scientific & Mobile) Ltd.
Stand No. 41

Newport Instruments' exhibit is mainly planned as a working demonstration of a simple and economical nuclear magnetic resonance equipment.

An electromagnet, Type A, mounted on a current stabilised power supply unit, Type B, provides a field of 5,600 gauss in an air-gap of 3 cm with a homogeneity of one part in 100,000 (56 milligauss) in a volume of ½ cc near the centre of the air gap.

A direct reading magnetometer, Type G, will also be exhibited covering the range to 1,000 gauss with a sensitivity of 10 milligauss per scale division, to examine the magnets' stray field and illustrations will be given of other standard electromagnets in the Newport range: 1½ in., Type C; 7 in., Type E; and 8 in., Type D.

The "Niometer" bonding and insulation tester will also be shown. This instrument contains a rugged centre-pole moving coil meter, a resin-encapsulated transistorised drive circuit, and mercury cells which will give many months of normal use. Resistance of any value from 200 megohms to 0·04 ohms can be measured directly.

Nuclear Enterprises (G.B.) Ltd. **Stand No. 81**

The firm will be displaying a range of scintillation materials and precision nucleonic instruments.

Included in the scintillation materials will be the plastic phosphor scintillator NE102 which may be used with burst slug detectors, special well counters, human body counters, high energy proton telescopes or thin sheets for alpha and beta counting.

Liquid scintillators, NE211, for gamma ray and neutron detection, will also be on display. Also included in the exhibit will be loaded liquid scintillators, scintillating gels and sodium iodide (thallium activated) crystals.

Among the precision nucleonic instruments to be shown will be a complete assembly for C14 and tritium counting—the NE8301. This assembly consists of a non-blocking linear pulse amplifier NE5202, a single channel differential pulse height selector NE5102, a stabilised E.H.T. supply NE5302, and a shielded scintillation head unit NE5502.

L. Oertling Ltd. **Stand No. 111**

Extensive tests with the first prototype quartz fibre ultra micro balance have led to a number of modifications and improvements incorporated in the production prototype will be shown. The instrument is designed to weigh with an accuracy of 0·1 microgramme, and to be capable of handling loads of up to about 0·5 g.

A new design of high speed precision semi-automatic balance giving dead-beat readings has a capacity of 2 kg in each pan and a sensitivity of 0·1 g per scale division.

The range of one pan balances, first introduced in 1957, incorporates full mechanical manipulation of all weights on all models.

The range of two pan balances now comprises fourteen different models with sensitivities ranging from 0·1 mg to 2 mg per scale division, and with different ranges of automatic weight manipulation.

Optical Works Ltd. **Stand No. 89**

W. Ottway & Co. Ltd. **Stand No. 94**

Among the new instruments this company will be demonstrating is the "Orion" 6 in. F8 Newtonian Astronomical telescope. The parabolic mirror is polished and figured with an accuracy to $\frac{1}{8}$ wavelength of visible light. The telescope body is of low thermal conductivity impregnated plastic tube.

A prototype slotted template cutter developed for the Ministry of Supply will also be demonstrated together with a laboratory reading and aligning telescope, survey levels, smoke density sighting equipment, oscillograph camera lenses and scaleometers.

Panax Equipment Ltd. **Stand No. 11**

Scintillation castles, Type SC/LP. The instrument is useful for the measurement of weak beta emitters in conjunction with liquid phosphors. Efficiencies of 60% for carbon-14 and 10% for tritium have been obtained at normal room temperatures.

Scintillation counter unit, Type USC/A. This unit comprises an eleven-stage photomultiplier holder and dynode potentiometer network with a shielded crystal mount designed to accommodate sodium iodide crystals of $1\frac{1}{2}$ in. and 1 in. diameter by 1 in. in length.

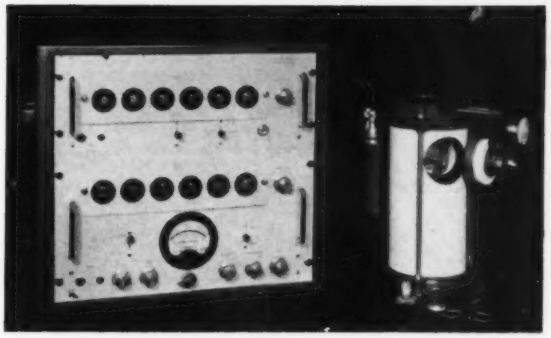
Directional scintillation counter, Type DSC/1. Good directional resolution is achieved using a one inch diameter sodium iodide crystal in conjunction with the collimator and removable insert, Type COL/2.

Universal lead castle, Type LC/3. This instrument has been redesigned and can now be used with Panax scintillation counters for both end window and well type counting.

Variable gain pulse amplifier, Type 4250. Three gain positions are provided of 50, 150, and 450. A cathode follower output stage develops pulses suitable for use with most scalers and discriminators.

Portable radiation monitors, Type TR56B and TR56H. The TR56B radiation monitor is calibrated in counts per minute with three ranges: 0-25,000 c/min, time constant 1 second; 0-5,000 c/min, time constant 1 second; 0-5,000 c/min, time constant 6 seconds. The TR56H radiation monitor is calibrated in mR/hr for radium gamma rays, also with three ranges: 0-50 mR/hr, time constant 1 second; 0-10 mR/hr, time constant 1 second; 0-10 mR/hr, time constant 6 seconds.

Automatic counting equipment, Type AC300/6. Facilities are provided both for timing against pre-set count and for counting against pre-set time. The count and timing channels each have six plug-in Dekatron units giving a range of pre-set counts up to 10^6 counts, and pre-set time up to 10,000 seconds for timing pulses of 100 pulses per second.



Panax automatic counting equipment AC300/6 with scintillation counter SC/LP.

Scaling attachment, Type SA/100. A simple scaling attachment designed for use as an add-on unit to the Panax ratemeter, Type 5054, or as a simple electronic counter. It consists of two plug-in Dekatron stages followed by a resettable mechanical register giving a total count of 999,999.

Paton Hawksley **Stand No. 112**

Graticules. Standard types of graticules for eyepiece micrometers will be shown on standard glass mountings. Rulings available include crossed scales, protractors, grids, cross wires, stadia rulings and dust counting graticules.

Scales. Metric scales to 500 mm length and inch scales to 30 in. to accuracy ±0·0001 in. Divided circles of radial rulings of accuracy to 5 seconds of arc will be shown.

Diffraction gratings for metrology. A range of diffraction gratings will be exhibited for instrument control including a new ruling by the National Physical Laboratory which has been designed especially for metric work.

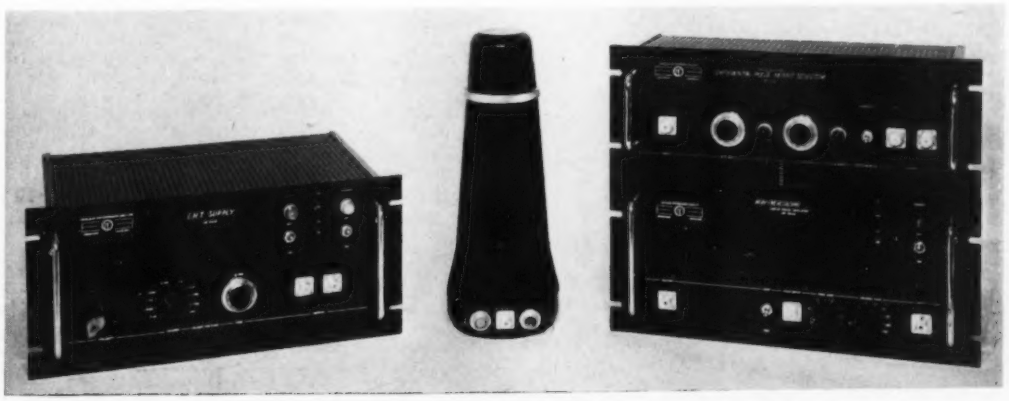
Strain indicator. A visual indication of strain or linear displacement of set up of printing type and other applications.

Diffraction gratings for spectrometry. A range of replica diffraction gratings produced by the Merton/N.P.L. process are primarily intended for use in the ultra-red region. Examples of these will be shown.

Physical Society **Stand No. 24**

Physical Society, Low Temperature Group **Stand No. 148**

Physical Society, Optical Group **Stand No. 152**



Nuclear Enterprises assembly for C14 and tritium counting, NE8301.

G. V. Planer Ltd. **Stand No. 133**

This exhibit of copper on glass printed circuits shows a new type of printed electronic circuit. The new process allows production of intricate circuit designs utilising relatively thick metallic films.

New types of indium antimonide magneto-sensitive resistor and Hall effect elements will be shown. The use of corbino disc elements of novel construction in variable reluctance type transducers will be demonstrated for applications such as in displacement measurement. Other types of elements shown are designed for use in various types of flux servo devices, flux meters, etc.

An electrolytic co-precipitation method of preparing mixed oxide powders suitable for the production of magnetic ferrites will be demonstrated.

An ignition unit incorporating a liquid filled polyester film capacitor for operation over a wide temperature range (−50°C to +150°C) under 2,000 volt pulse conditions will be exhibited.

New types of temperature stable barrier layer ceramics with effective K values of 300,000 and low dielectric losses and 0·5 μF capacitors encapsulated in epoxide resin will be shown.

Other exhibits will include: high temperature piezoelectric and dielectric ceramics; a selection of oxide and metal film resistors; a range of soft and hard magnetic ferrites; single crystals of titanates and niobates; non-ferroelectric ceramics of the relaxation polarisation type; flame sprayed high-K ceramic dielectrics; ceramic to metal bonds as applied to ceramic accelerometers; magnetic recording tape with high longitudinal strength utilising forward-drawn polyester base; vacuum metallised polyester and other plastic foils for capacitor and transducer applications.

Plessey Co. Ltd. **Stand No. 19**

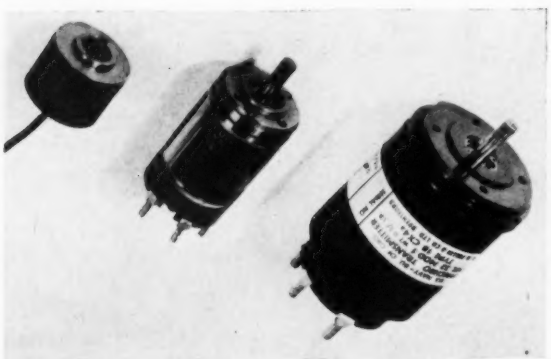
Post Office Engineering Research Station **Stand No. 30**

Precision Tool & Instrument Co. Ltd. **Stand No. 83**

Prior, W. R., & Co., Ltd. **Stand No. 96**

R. B. Pullin & Co. Ltd. **Stand No. 113**

R. B. Pullin will be showing for the first time the 7-terminal size 11 control resolver R982-21B Bu-Ord 11R13N4 and a 6 V miniature governed speed motor with adjustable governed speed which is intended for 1,000 hours continuous operation without attention and is designed to take minimum possible current from the battery. On the stand there will also be: samples from the Pullin-Kearfott range of size 11 and size 18 synchros and size 10 servomotors for germanium and silicon transistor-amplifier operation; size 10 motor generator with 400 c/s motor and an integral damping generator; type TAIG miniaturised resin encapsulated germanium transistor amplifier; a range of standard and governed speed permanent magnet d.c. motors; Type 18 PMT tachometer generator which is suitable as a linear voltage signal source for integrating and computing circuits; and an in-line, rear-projection type digital display unit.



Pullin-Kearfott servomotor and synchro transmitters.

Pye Dynacap pH meter.

Pye, W. G., & Co. Ltd. **Stand No. 104**

The Pye argon chromatograph using an argon detector will be exhibited. Examples of pH equipment will include a portable meter, a Dynacap meter, a Dynacap industrial meter, and a flow type pH electrode assembly. The remainder of the exhibit will consist of a decade potentiometer stabilised power supply unit, galvanometer, l.f. oscillator instrument switch, portable Wheatstone bridge, decade resistance boxes, electrostatic voltmeter, thermocouple test set, high resistance test set, single channel recording thermometer.

Racal Engineering Ltd. **Stand No. 42**

Rank-Cintel Ltd. **Stand No. 116**

Royal Meteorological Society **Stand No. 44**

Royal Swedish Academy of Engineering Sciences **Stand No. 151**

Royston Instruments Ltd. **Stand No. 33**

The MIDAS system of magnetic tape data recording and processing uses a frequency modulated carrier and ½ in. tape, giving simultaneous recording of seven signal channels and one reference channel. The range of recorders covers transportable, rack mounting, continuous loop and miniature flight recorders. The calibrator and playback unit and analyser will also be exhibited.

Salford Electrical Instruments Ltd. **Stand No. 26**

Sanders, W. H. (Electronics) Ltd. **Stand No. 18**

Sangamo Weston Ltd. **Stand No. 140**

Science Museum **Stand No. 56**

Science Museum's exhibit will consist of a model on a scale of 1:24 of "ZETA", the Harwell controlled nuclear fusion apparatus.

Servomex Controls Ltd. **Stand No. 3**

Shackman, D., & Sons **Stand No. 86**

This firm will be exhibiting a 70 mm film camera for the first time. It has been developed to provide a larger format area (2 × 2 in.) than that obtained with the normal 35 mm film cameras. The camera will be used for instrument, document and oscilloscope recording. In addition to the larger picture area, the film capacity has been increased to 200 ft. The camera may be operated automatically for shot-by-shot recording requiring only a single electrical impulse of 24 volts to operate the focal plane shutter and transport the film ready for the next exposure. For continuously moving film photography the film speed is infinitely variable between 40 in./sec and 1 in./sec.

Siemens Edison Swan Ltd. **Stand No. 150**

Singer Instrument Co. Ltd. **Stand No. 143**

Smith, S., & Sons (England) Ltd. **Stand No. 121**

Solartron Electronic Group Ltd. **Stand No. 103**

The infinite persistence Solarscope, Type QD.910, which uses a "Memotron" cathode ray tube, enables traces to be stored for any period without deterioration and yet be erased in a fraction of a second.

Double beam Solarscope, Type CD.711S.2, is the improved CD.711 introduced in 1958, it has Service approval as CT.414. Measuring Solarscope CD.643.2 is the improved model of the oscilloscope introduced in 1958. Transistorised power supplies covering the range from 0 to 50 V will be shown.

The transfer function analyser reference resolver JX.746 provides direct R and θ digital presentation when using the Solartron transfer function analyser (T.F.A.) for routine or production testing. Solartron process response analyser JY.743 has been designed for the study of process control systems and performs transfer function analysis in the frequency range of one cycle per three hours to 100 c/s. Several Solartron programmed actuators will be shown.

A SPACE analogue computer with 20 drift corrected d.c. amplifiers, several general purpose diode function generators and general purpose servo multipliers will be demonstrated as solving a number of practical problems.

A general purpose diode function generator TR.829 provides a non-linear function up to 20 break-points, each individually adjustable between −100 V and +100 V by push-button potentiometers. A general purpose servo multiplier TJ.725 is a shaft-position servo unit which can be supplied as a multiplier, resolver or tapped potentiometer function generator up to 5 outputs. The Hall effect multiplier has special transistorised circuit arrangements to compensate for magnetic material and Hall coefficient variations. It enables computing accuracies of 0·1 per cent instead of the usual 1 per cent to be obtained in this type of equipment. A fast parallel binary adder employs an and/or logic which greatly increases its speed compared with normal binary adders.

The X-ray fluorescent spectrometer XZ.736 has improvements which enable elements of atomic number below 20 to be analysed.

The precision force measuring equipment, based on a design developed with Mechanical Engineering Research Laboratory (D.S.I.R.), measures a force of up to 500 lb with an accuracy of 0·2% of the applied load plus 0·1% of the full load.

A wideband high gain d.c. amplifier is designed to accept small d.c. voltage with transients up to several thousand cycles per second from strain gauges, electro-mechanical devices, etc., and amplify the signal for conventional recording instruments. A transistorised three window digital indicator gives digital indication of voltages from 0 to 999 with three figure accuracy, black or red background illumination indicating voltage polarity.

The Solartron digital print-out is a digital printing device having parallel decimal input, which prints each line of digits simultaneously. The Solartron recorder/reproducer type LW.780 consists of a seven-channel system housed in a single cabinet, while additional amplifiers, power supply and blower unit for a fourteen-channel system are housed in a second cabinet. A selection of Solartron transducers for data handling will also be shown.

Solus-Schall Ltd. **Stand No. 45**

Generator for crystallography. The No. 49921 unit, with a full wave metal rectified output of 60 kV peak and up to 140 mA, is arranged to energise one to two sealed off pattern X-ray diffraction tubes mounted on separate work tables.

Work table unit, No. 49925, is constructed to support one or two X-ray diffraction tubes, diffractometers and cameras.

X-ray diffractometer, No. 50200, is used for determining the position, intensity, and width of diffraction lines from polycrystals or from single crystals in the plane of motion of the counter tube.

The electronic fast counting ratemeter/amplifier, No. 50211, for X-ray diffractometry, incorporates a stabilised E.H.T. supply, variable gain control, discriminator, cathode follower output circuit for a scaler, recorder, etc., and ratemeter ranges from 0 to 100,000 pulses per second.

Dekatron gated counter scaling unit, No. 50212, has been designed primarily for use with diffractometers and ratemeter/amplifiers so that the number of individual counts arriving in a predetermined time is recorded, or, more conveniently, the time is recorded for a certain number of counts.

Inching device, No. 50213, for the angular degree per minute control of a diffractometer. The "inching" intervals are for 1, 2, 3, 4, 5, 6, 8, 10, 12 and 15 minutes of "Bragg" angle, with an alternative for continuous running.

Chart recorders, No. 50220. These have fast response milliammeter movements, using a continuous line ink pen on synchronous motor operated charts, for tracing diffraction intensities obtained by counter techniques in conjunction with ratemeter/amplifiers such as No. 50211, etc.

Standard Telephones & Cables Ltd. **Stand No. 34**

Stanley, W. F., & Co. Ltd. **Stand No. 137**

Stanton Instruments Ltd. **Stand No. 109**

Stott, Dr. F. D. **Stand No. 59**

A resistance thermometer, consisting of a conventional type of self-balancing bridge using only transistors, has been developed for measuring and recording body temperature in man or animals during surgical hypothermia.

A simple pneumatically operated pressure recorder, which can be run off a gas cylinder or a compressor, will be shown. This instrument is intended primarily for measuring aesophageal or CSF pressures. Ranges from 0-10 mm Hg to 0-250 mm Hg can be obtained from the same measuring head.

A high speed red cell counter is still in an early stage of development. A cathode ray tube flying spot scan generator is used to scan a standard haemocytometer chamber. The scan is 100 lines, 1 frame/sec with 100 kc/s spot wobble.

Sunvic Controls Ltd. **Stand No. 129**

Techne (Cambridge) Ltd. **Stand No. 32**

Telegraph Construction & Maintenance Co. Ltd. **Stand No. 130**

Thermal Syndicate Ltd. **Stand No. 88**

The applications of "Spectrosil" have been developed so that apparatus can be made of it. In its optical form it can be used to transmit ultra-violet down to 1,650 Å. Large transparent panels of fused quartz for viewing windows where high temperatures are involved and lengths of tubing of various cross-sections will be exhibited.

Thompson, J. Langham, Ltd. **Stand No. 29**

In the recording camera section will be seen the improved version of the Series 200 oscilloscope camera.

The new BP series of pressure transducers has an overall accuracy of better than 1% at full output. Models BP1 and BP2 are of resistance and differential strain gauge bridge construction respectively, whilst Model BP3 is intended for the measurement of both steady and rapidly fluctuating pressures.

Another development is a pair of unbonded strain gauge dynamometers designed for the measurement of steady and rapidly fluctuating tensile and compressive forces. One has a range of 4 oz to 2 lb, the other from 5 lb to 200 lb.

A series of unbonded strain gauge load cells also makes its appearance this year for the first time. Designed for the measurement of compressive loads over a range from 500 lb to 100,000 lb, these cells have an accuracy of 0·15%.

The new range of differential inductance transducers performs three different functions, by measuring (1) pressure (100-3,000 p.s.i.), (2) linear displacement (0·005 in.) and (3) angular displacement (45°, 90°, 180°, 320°).

Also on display will be a new range of displacement transducers.

An interesting device is the new transistorised G meter for use with barium titanate or lead zirconate accelerometers. This meter will read values up to 100 g and is operated via the J.L.T. cathode follower unit G.F.1.

A range of digital indicating equipment will be on show for the first time. This range divides itself into three groups: frequency meters, chronometers, and counters, all of which have provision for operating one or two additional remote indicating units.

In the field of regulated voltage supplies, versatility of the Sorensen and Nobatron ranges has been increased by the introduction of low voltage, high current models. Three new transistor regulated d.c. power supplies are also available.

Thorn Electrical Industries Ltd. **Stand No. 48**

H. Tinsley & Co. Ltd. **Stand No. 119**

Cable fault locator, Type 5335. This instrument utilises a conventional Wheatstone bridge circuit in which the two sections of the faulted conductor, one on each side of the fault, comprise the two external arms of the bridge.

Flash fault locator, Type 4520. This instrument is intended for the location of faults which are apparent only at high voltage and which heal at low voltage.

Resistance standards. A selection of resistance standards is being shown, some making use of Karma wire and novel methods of construction.

Standard cell battery, Type 5312A. The standard cell battery is intended for use as a standard of e.m.f. where greater precision is required than can be obtained using a single standard cell.

Standard cell comparator, Type 5256A. This instrument is designed to compare standard cell voltages to the order of 1 μV when used in conjunction with the batteries mentioned above.

Thermal conductivity probe, Type 5317. The thermal conductivity probe is a practical tool for the rapid measurement of the thermal conductivity of thermally insulating materials.

Transient needle probe, Type 5230A. The measurement of thermal conductivity of soils is of importance in survey work where electricity cables or pipes carrying hot fluids are to be buried.

Epstein square, Type 5348. Designed for American Society for Testing Materials method A343-54, this instrument allows measurements to be made of the core loss of flat-rolled magnetic materials at frequencies up to 2,000 c/s and at inductions in the range 1 to 10 kilogauss.

Contact modulated amplifier, Type 6036. The instrument shown has an overall voltage gain of 10^7 with a noise level equivalent to 0·01 μV. It has been designed to operate a recorder or indicating meter of resistance about 500 ohms.

Galvanometer—photo-cell amplifiers in series. The Type 5214 amplifier uses barrier layer photo-cells and provides an output current suitable for use with a secondary indicating galvanometer; it has provisions for varying the feedback and also for applying the feedback in series or parallel, thus affording a wide range of input conditions. The Type 6035 makes use of a vacuum photo-cell and thyratron powered from a.c. mains; its output circuit is designed to deliver 20 mA into 2·5 kΩ for recorder operation with an input of 0·1 μV. The exhibit shows both amplifiers operating in series, utilising the microvolt sensitivity of the Type 5214 amplifier and the output characteristics of the Type 6035 amplifier.

Furnace flame indicator. This instrument in its usual form is as installed in Central Electricity Authority generating station boilers to give remote indication of combustion conditions.

Frequency selective amplifiers. Based on a National Physical Laboratory design, the Type 5141 amplifier uses two parallel-T feedback amplifier stages having a novel manner of connection.

Transistor amplifier in vibrating galvanometer Type 5311A. The Type 5311A galvanometer has a self-contained amplifier built in its case with a variable control giving a gain of up to about 10. It is convenient for use with a.c. bridges in the range 40 to 500 c/s.

Tintometer Ltd. **Stand No. 90**

Complete kits of simple apparatus for colorimetric tests in the printing industry have been designed to include tests for the pH of the surface of papers and of aqueous paper extracts, the pH of nickel in plating baths, the copper content of electrotyping baths, and silver in used hypo baths. A much simplified colour comparator for ascertaining that a swimming pool is correctly adjusted for pH and free chlorine content between agreed safe limits will be exhibited.

There will be a new model of the B.D.H. Lovibond Nessleriser and artificial light attachment, for colorimetric chemical analysis: the fadeless colour standards are of Lovibond glass.

One of the interesting new developments which may be seen is the application of the Lovibond portable tintometer to the measuring of the colour of illuminated cinematograph screens.

J. W. Towers & Co. Ltd. **Stand No. 126**

Two types of counter current apparatus will be exhibited: a micro-scale automatic type for the separation by multiple extraction of milligram quantities of alkaloids, amines, amino acids, antibiotics, peptides, steroids, vitamins, etc., and a hand operated one for demonstration or use by students.

An automatic fraction collector for use in chromatographic analysis, which was designed at the National Institute of Medical Research will be shown. Other exhibits will include a Craig type rotary evaporator, a fixed condenser rotary film evaporator, and a range of automatic and analytical balances, electric ovens and incubators.

Townson & Mercer Ltd. **Stand No. 108**

Type 3 vacuum oven. This is a new version of the standard size of vacuum oven.

X.27 major thermostat bath. This is the production version of the new type of precision thermostat bath developed last year. It incorporates a new type of straight line stirring. It is specifically intended to comply with present and future A.S.T.M. and I.P.T. viscometry test specifications, up to 120°C.

Vacuum moisture tester. This instrument takes a 5 g sample and indicates the actual moisture content direct on a dial.

Duplex thermostatic incubator. This has been developed to add a further safety factor to incubators or thermostats which are being used for long periods with valuable contents.

High temperature oil bath. The latest design utilises a steel tank with a weir, behind which is a propeller giving straight line stirring.

Twentieth Century Electronics Ltd. **Stand No. 6**

Ultrasonoscope Co. (London) Ltd.
Glass Developments Ltd. **Stand No. 145**

Glass Developments Ltd. will exhibit an ammonia maser oscillator similar in design to that developed by the Signals Research and Development Establishment, Christchurch. This instrument is the first step of an S.R.D.E. programme which aims at a portable maser and a high precision 1 Mc/s frequency standard.

They will also show number 145 transistorised headsets for receiving audio loop messages in noisy conditions.

The Ultrasonoscope Co. (London) Ltd. will demonstrate search probes. These will include a 3 mm crystal diameter probe for the inspection of spot welding; probes employing lead zirconate crystals giving increased sensitivity and shorter pulse lengths and a special turbine testing probe developed on behalf of the Central Electricity Generating Board for the inspection of turbine blades *in situ*.

A new general purpose portable flaw detector, the ultrasonic flaw detector Mark II, will be demonstrated.

Fast timebase speeds and high trace brightness combine with a rectified or unrectified trace display to enable a comprehensive study of echo shape. The operational frequency range of $\frac{1}{2}$ Mc/s—10 Mc/s extends the possible application range over a very wide number of test problems.

Unicam Instruments Ltd. **Stand No. 102**

The SP.700 recording spectrophotometer automatically records transmittance or absorbance on a linear wavenumber scale in the range from 54,000 cm^{-1} (186 mμ) in the ultra-violet to 2,800 cm^{-1} (3·57 μ) in the near infra-red.

The Unicam spectrofluorimeter is an example of a method of unit construction by which it is intended to make available, at reasonable cost, a wide range of specialised spectroscopic equipment.

The units here concerned are: a source unit, a primary monochromator consisting of a Littrow silica prism, a photometer unit which measures fluorescent light output as a ratio of exciting light, a secondary monochromator and a detector which consists of a photomultiplier with an electronic system to give null indication of an arbitrary ratio between the two beams.

The spectrofluorimeter allows irradiation of a liquid with monochromatic light of any wavelength within the range 220 mμ to 1,000 mμ and measurements of resulting fluorescent light at any selected wavelength within the same range.

United Kingdom Atomic Energy Authority Stand No. 51

Atomic Weapons Research Establishment.

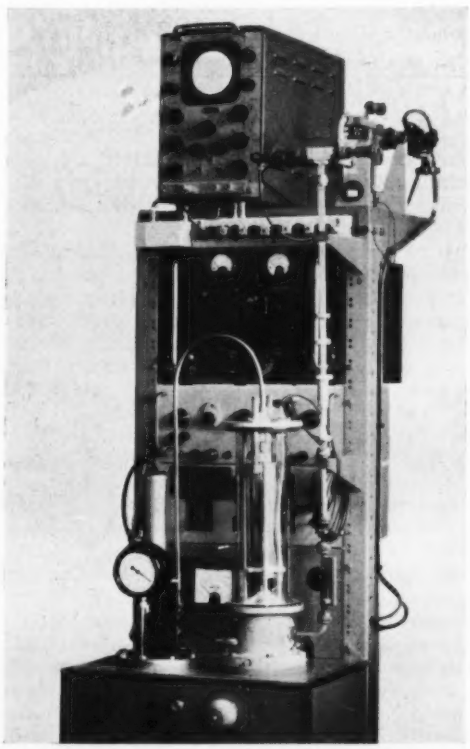
Automatic burette monitor with electronic register. Two types of monitor will be shown. Type A automatically registers on a paper tape the liquid height in a burette. (A typical use is to record the end-point in a titration experiment.) Type B automatically follows variations of liquid height and records them in the form of a graph.

The automatic magnetic field control system is intended for the stabilisation of electro-magnetic fields which are capable of being varied over wide ranges and must be remotely controlled.

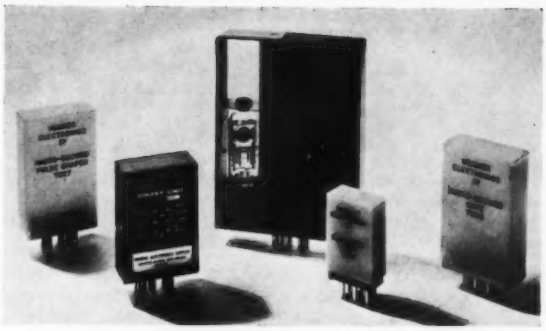
The travelling wave oscilloscope has been designed for high speed transient recording, requiring only small signal input voltages. The nominal bandwidth is from d.c. to 2,000 Mc/s when direct coupling to the co-axial deflector system is made; and from a few kilocycles when using the d.c. blocking condensers and push-pull transformer.

Very high speed electric motors. Rotating mirrors are usually employed as scanning elements in streak and cine cameras when the highest speeds are required, and a range of electrical drives has been developed to cover some of the rotational speeds demanded.

High speed cameras. For many laboratory events connected with fast, heavy current discharges, peak light output is in the region below 3,500 Å. The rotating mirror streak camera which will be shown will take photographs at wavelengths down to the gelatin limit on standard film.



Ammonia maser (Glass Developments Ltd.).



Venner transistorised packaged stages.

Specific heat of plutonium metal. Plutonium is extremely toxic and chemically very reactive; thus any work on the metal involves the use of a sealed enclosure such as the one shown in the exhibit.

Atomic Energy Research Establishment, Harwell.

Differential cathode ray polarograph. The instrument is a development from the linear sweep cathode ray polarograph. The direction of potential sweep can be reversed to permit thermodynamic reversibility of reactions to be studied and variable slope correction is provided to facilitate peak measurements at high sensitivities. Derivative polarography using single cells may be carried out.

United Kingdom Atomic Energy Authority and Radiological Protection Service.

Personnel radiation monitoring using photographic emulsions. The exhibit, which is in four sections, will cover some recent developments in film holders and specialised films and also the operation of a monitoring service with examples of data derived from the records.

Patents Exploitation Department.

Low inductance capacitor (Brit. Pat. Appl. No. 7560/58). A reliable rolled foil capacitor having a very low inductance has been developed by the Authority. A typical capacitor having a capacity of $\frac{1}{2}$ μF and a working voltage of 10 kV can be charged and discharged 5,000 times without breakdown, the ringing frequency of the discharge being 2 Mc/s.

Impregnation of fibrous filter units with oil (Brit. Pat. Appl. Nos. 25303/57 and 1137/58). The methods used in this invention showed that there was a more even distribution of oil throughout the filter, complete penetration through the thickness of the filter, elimination of the fire hazard, decrease in impregnating costs and better performance obtained from the impregnated filter.

Atomic light sources. As with radium activated luminous paint, these lamps rely upon the excitation of phosphors by the beta particles emitted by radioactive krypton gas (Kr 85) or tritium (H^3).

Venner Electronics Ltd. Stand No. 13

The latest additions to the Venner range of plug-in stages include the crystal oscillator, Type TS25, which will function at frequencies between 100 kc/s and 1 Mc/s (depending on the crystal employed). This unit can be used to give either a sine wave out, or alternatively a pulse waveform. A further addition to the range of crystal oscillators is the TS30 which is a low frequency oscillator for use with XY flexure crystals. This block will cover the range from 5 kc/s to 100 kc/s.

Another new item is the 1 Mc/s binary unit which is available in two forms, the TS2A/HF which is suitable for divide-down chains where a division ratio other than in multiples of two is required, and the TS2B/HF which is particularly designed for use with the microsecond gate, Type TS36. This gate can be opened and closed by varying the d.c. level of the control pin from −9 V to −4 V with a 10 V supply, these levels being conveniently provided by the binary unit, Type TS2B/HF.

The microsecond pulse shaper, Type TS27, is designed to provide a pulse suitable for triggering binary and decade units from a wide range of waveforms at frequencies up to 1 Mc/s. The output consists of positive-going pulses of approximately 8 V amplitude, 0·4 μS width, and having a rise time less than 0·2 μS at 1 Mc/s.

Also available is the 1 Mc/s decade unit, Type TS10/HF, which drives a meter calibrated 0-9 to give indication of the count which has been achieved.

The electronic reset unit, Type TS32, is intended for use with any binary or decade stage and is capable of resetting these within 4 μS when triggered by a negative-going pulse. No contacts are employed, the operation being entirely electronic.

W. Vinten Ltd. **Stand No. 80**

The range of Vinten 16 mm cine cameras remains virtually unchanged. It includes the 16 mm scientific camera Marks I and II, a 16 mm high speed camera and a light instrumentation camera.

Watson, W., & Sons Ltd. **Stand No. 95**

The firm will be showing a full range of stereoscopic microscopes.

In addition, the new "Bactil" microscope will be shown. This new model has all controls below the stage.

The Wayne Kerr Laboratories Ltd. **Stand No. 12**

The measurements laboratory will be showing examples of the transformer ratio-arm bridge technique applied to electrochemistry, mechanical engineering and industrial process control. Measurement of the conductivity and permittivity of liquids will be featured. The special products division, which is concerned primarily with the development and application of resin-cast circuits, will be exhibiting a range of high-voltage apparatus in which the superior dielectric properties of casting resins have made possible the miniaturisation of this apparatus.

Production and prototype instruments exhibited are:—

Vibration meter, Type B.731A. Distance and vibration amplitudes from 50 micro-inches to 0·5 inches can be measured accurately in the frequency band 1 c/s to 10 kc/s.

The electronic micrometer, Type B.721, is designed to measure with very high accuracy distances in the range 0 to 45,000 micro-inches. Precision low impedance comparator, Type X.821. The design is based on a three-terminal transformer ratio-arm bridge circuit giving a very high degree of discrimination and stability.

Precision high impedance comparator, Type X.921. This instrument compares impedances of the order of megohms against a known standard by providing a voltage ratio adjustable between 1 : 1 and 3 : 1 to six significant figures.

Precision a.f. voltmeter, Type M.121. The production prototype demonstrated measures either (a) absolute voltage levels from 1 millivolt to 100 volts r.m.s., or (b) relative levels in dB with respect to 1 milliwatt into 600 ohms over the range −73 to +40 dB.

The short duration pulse generator, Type P.131, has been designed to provide pulses of short duration now required for the development and servicing of modern radar and allied equipment.

The transistor adapters were developed specifically for the Wayne Kerr Radio Frequency Bridge B.601 to facilitate the measurement of α and the Y-parameters of transistors.

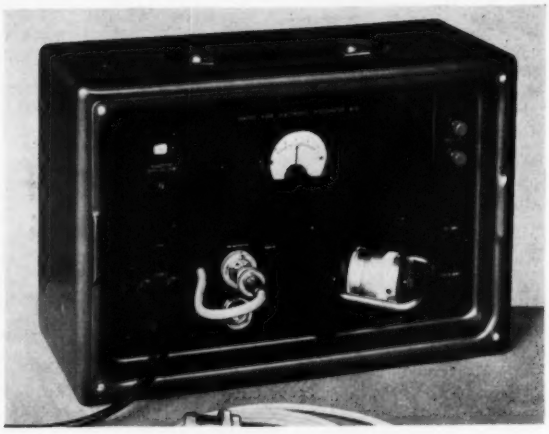
The crystal activity tester CT.79A is a new instrument being developed for the Ministry of Supply for production tests on quartz crystal units.

Very high frequency admittance bridge, Type B.961. This bridge has been designed to measure complex admittances in all four quadrants.

Modulation meter, Type X.11626. This equipment has been developed for the Royal Aircraft Establishment to be used in conjunction with the Instrument Landing System. It measures the modulation depth of the glide path and localiser transmitter operating in the bands 108-112 and 329-335 Mc/s.

Microwave milliwattmeter, Type U.281. This resistive film bolometer wattmeter is designed to measure microwave power in the range 1 to 100 milliwatts in the band 8·4 to 10·2 kMc/s.

Resonant cavity wavemeters. Seven resonators developed for the Royal Aircraft Establishment are exhibited. Together they cover the frequency range 1-40 kMc/s.



Wayne Kerr electronic micrometer.

A 10-50 kV pulse voltmeter has been developed for the U.K.A.E.A. to meet the need for a high-voltage peak-reading voltmeter with a fast response time.

0-30 kV d.c. voltmeter. This instrument, which has been developed for A.S.R.E., is a general purpose voltmeter with centre zero, enabling measurements to be made irrespective of polarity. A range of power supplies is available and units have been designed operating on 50, 150, 400 and 1,000 c/s input frequencies. The transformers used in the d.c. power supplies are available as separate resin-cast items giving outputs up to 50 kV r.m.s.

A range of pulse transformers is also available operating from capacitor discharge networks.

Westminster Hospital **Stand No. 57**

NEW PATENTS

Patent No. 794,139. Photo-electric Sensing of Symbols and Figures

Johannes Friedrich Lorenzen (Germany). (*Application No.* 666/56.)

The general principle of the invention is as follows: the reflection of a voucher or other document passes through an opening and, after refraction through a mosaic screen comprising a number of circular perforations, passes to a corresponding number of reducing lenses. These lenses direct the convergent beam on to a field having the same number of selenium cells. These cells are connected with an associated relay in such a manner that the configuration of the letter or symbol is sensed and transmitted in mosaic for mechanical reproduction on a record or for the appropriate actuation of the key of an office machine.

Patent No. 794,171. Electronic Calculating Apparatus

International Business Machines Corporation (U.S.A.). (*Application No.* 33426/54.)

The main object of the invention is to provide an apparatus which is extremely versatile and whose programmes are relatively simple as compared with a stored programme type of calculator in which the programme is stored in memory.

Patent No. 794,309. Speed Responsive Electric Switches

Gaylord Products Incorporated (*U.S.A.*). (*Application No.* 19243/56.)

With the development of motor vehicles having automatic transmissions, creeping of the vehicle, that is slow unintended movement of the vehicle at engine idling speeds, frequently occurs. In vehicles with conventional manual transmissions, movement which is not intended may occur when the vehicle comes to a stop on an incline. To prevent such movement from either cause devices have been introduced comprising a solenoid operated valve in the hydraulic brake line of the vehicle, the solenoid being in series with a suitable electric switch operable with the vehicle accelerator and a control switch unit responsive to movement of the vehicle. This invention relates to a switch unit which, it is claimed, greatly simplifies the association of the unit with the speedometer cable, the rotation of which, when creeping occurs, causes the switch to open a circuit resulting in the activation of the solenoid and application of the brakes.

Patent No. 795,239. Control Devices for Reversible Fluid-pressure Motors

The Plessey Company Ltd. (*Inventor D. C. Atkins.*) (*Application No.* 33720/54.)

The main object of this invention is to provide means whereby the controlled motor after being started will operate for a pre-set time and is then stopped automatically. The principle of the device provides for the output shaft of the motor being coupled via a reduction gear with the first element of a differential. A second element of this differential is connected with a link mechanism arranged for controlling the flow of fluid through the motor and has a third element rotatable by the movement of a control lever which is selectively adjustable. One position of the control lever causes the link mechanism to start the motor which rotates the first element in such a direction that the effect on the third element of the differential, produced by the displacement of the control lever, is neutralised whereby the motor automatically stops after a certain number of revolutions pre-determined by the setting of the control lever.

Patent No. 795,525. Indicating and/or Measuring Instruments

The British Iron and Steel Research Association. (*Inventors: Charles Burns and Samuel Skipton Carlisle.*) (*Application No.* 27651/54.)

The instruments described in this specification are particularly concerned with those adapted to indicate the location of the edge of a strip or like long continuous member which provides a radiation different from that of its surroundings. Examples are the edge of a hot steel strip radiating infra-red waves and a cold steel strip illuminated from beneath by a source of light. The invention comprises a detector means, sensitive to the radiation emanating from the vicinity of the edge of the strip and giving an output dependent on the lateral position of the edge. This detector device comprises a shutter located between the edge and the sensitive device, the shutter being movable transversely providing an indication of the location of the edge, and a control mechanism controlled by the sensitive device for driving the shutter so that the output is maintained substantially constant irrespective of the lateral location of the edge. The shutter thus follows the movement of the edge and its location at any moment is an indication of the position of the edge. The shutter drive mechanism may be associated with an indicator to enable the position of the strip to be observed visually. Two instruments coupled together can be used so that a difference in position of the two shutters is proportional to the width of the strip.

Patent No. 795,753. Electric Micromanometer

Compagnie pour la Fabrication des Compteurs et Materiel d'Usines à Gaz (*France.*) (*Application No.* 11346/56.)

The invention concerns the provision of an electrically operated micromanometer of the diaphragm type for measuring pressure or pressure differences in a fluid with high accuracy and great sensitivity over a wide pressure range and at low pressures of the order of a tenth of a millimetre of water.

The instrument can be used in two ways: as an ordinary manometer, to measure the difference between a pressure and one for which the instrument is calibrated; or to measure pressure differences by measuring the deformation of two diaphragms which are subjected to pressures.

In principle the instrument comprises two pairs of electric windings within a chamber filled with an insulating liquid and bounded by two diaphragms subject to pressures, the difference between which is to be measured. The axes of the two windings are perpendicular to the diaphragms and the deformation of the diaphragms produces a variation of the mutual inductance of the windings. A measuring circuit measures this variation of pressure.

Patent No. 795,954. Central Remote Control

Landis & Gyr, A. G. (*Switzerland.*) (*Application No.* 23108/54.)

This invention relates to central remote control or broadcast control installations for enabling switching orders in the form of a programme of repeated double control signals, such as "On" and "Off" switch orders, to be sent from a control station, through the electric energy distribution network, to all consumer stations, for controlling the tariff of meters or for switching on or off boilers, furnaces, street lighting, etc., or for control of oil switches. In special circumstances it provides for sending other special orders such as an alarm for warning the population of threatened catastrophies, e.g., shortage of water or, in wartime, impending attack by aircraft. In the present invention such an installation is operated by the timed impulse method wherein a normal order programme is given in the form of double signals and for the purpose of special orders the normal order programme transmitter is acted upon with the aid of a special-order transmitter to vary the double-signal sequence at at least one point.

DEAD RECKONING

Part 2

By D. A. Senior, M.A., A.M.I.E.E.

Log Errors

FIRST it is necessary to examine some of the problems which are brought about by installing the log on the ship's bottom instead of towing it. The aim of all logs is to measure the speed of the ship relative to the body of water surrounding it but no log can do more than measure the relative velocity at the point where it is situated. If the log is close to the ship, even though outside the frictional belt, the velocity it encounters depends on its situation in the ship and on a number of other factors: for example, the water flow around the hull takes on different patterns at different speeds. This leads to departures from the basic linear or square law of the log, so that corrections have to be applied. The magnitude of the correction varies with marine growth which influences flow conditions, with any sideways movement of the ship due to wind or turning and finally with the amount of rolling, yawing and pitching of the ship. There is no simple way of allowing for the effects of marine growth, though the navigating officer can make an estimate of the correction he should apply from the length of time since the log was last calibrated. The effects of leeway are minimised by designing the log to give an indication which is independent of yaw angle as far as possible (the yaw angle is the angle between the axis of the ship and the direction of water flow of the log). Even so, the angle between the ship's heading and the course made good has still to be estimated. The estimation of this angle, or the leeway which determines it, is very difficult, largely because it depends not only on the wind velocity at right angles to the ship's course but also on the steering characteristics of the ship and on the speed with which the helmsman is able to correct changes of ship's heading due to gusts of wind. Indeed if the helmsman is slow to respond the ship may "bore to windward" so that the leeway is negative.

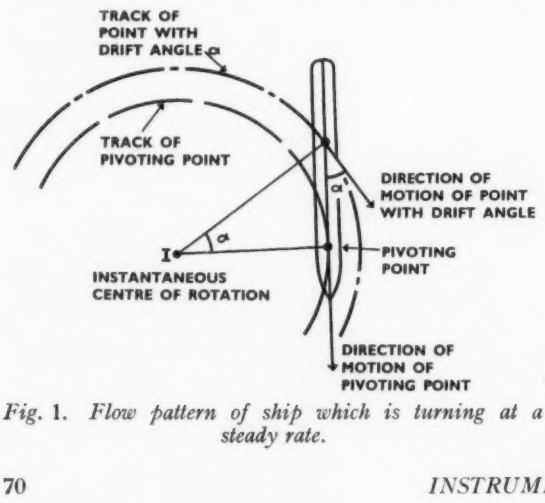


Fig. 1. *Flow pattern of ship which is turning at a steady rate.*

When the ship is under helm considerable changes in the flow pattern occur. An idea of these can be gained from Fig. 1 which shows how a ship, which has settled down to a steady rate of turning, acts as though it were rigidly connected to a point some distance out on the beam. If a perpendicular is dropped from this point on to the ship's axis, it meets the axis at a point P, known as the pivoting point. Here the motion is along the axis of the ship but at all other points and in particular at the point where the log is situated the motion is at an angle to the axis. This angle is known as the drift angle and there is reason to believe that the angle of yaw at the log is even greater than the drift angle. Thus the log probably exhibits a yaw error and it also fails to indicate its true direction and motion.

Error due to Leeway

Towed logs, whilst immune from some of these troubles, have troubles of their own, especially in rough or following seas, although being remote from the ship they have a chance of indicating true speed relative to the water, i.e., including the leeway component; but the leeway must still be known in order to correct for ship's course. In any case the vectorial addition of leeway at right angles to ship's forward velocity makes little difference to the magnitude. Thus the leeway affects the accuracy of the log and moreover introduces a considerable error directly, and here, with surface vessels, lies a good deal of the art of a navigator.

It is necessary for the navigator to build up in his mind a picture of the response of his ship under all conditions of weather and loading. He acquires his experience in the following way. The true position of the ship at morning and evening are known as long as conditions are favourable from astronomical observation, whilst the dead reckoning position can be calculated from course and speed. Allowance must then be made from effects of ocean currents and tides and the remainder of the error can be attributed to leeway. One of the drawbacks of this procedure is that whilst the

predominant ocean current will tend to average out in time and runs with and against the tidal stream will eliminate this source of error, the error due to water movement induced by the wind itself (surface drift) will not cancel out as it is a systematic error arising from the same source as the leeway itself. Rules for calculating surface drift have to be very rough, and as the drift is of the same order as the leeway itself with many ships it is extremely difficult to form an accurate idea of the leeway the ship will make under given wind conditions. Calculation of the effect of wind, if a zig-zag course is steered, is even more difficult and the methods which most navigators use inevitably lead to accumulative error along the mean line of advance of the ship.

Leeway then is a major source of error and although the master of a merchant vessel plying the same rule for a long period has good opportunities for observing his ship, there must be few who would guarantee their estimate of leeway to better than ½ a knot in winds of strength 5 upwards.

The problems of varying water flow around the ship and leeway have been discussed mainly from the standpoint of surface vessels. With a submarine the problems are much simpler. Wind forces are absent, and the submarine when submerged does not roll or pitch. When the submarine maintains a steady course and speed the log has the best chance of all. Water movements due to currents and tidal streams, however, affect the submarine just as much as they do the surface vessels.

Ocean Currents and Tides

Information about ocean currents is collected by the Marine Branch of the Meteorological Office, mainly from certain ships of the merchant navy who supply data on dead reckoning positions, astronomical observations and land fixes. Estimates are also made for leeway but no allowance is made for expected current. The Meteorological Office after careful selection (certain results are rejected if the astronomical observations are in doubt on account of atmospheric conditions or if the length of the day's run is so great as to average out the effects of currents over too great an area) compute the currents and publish them in three kinds of chart. These give vector mean direction and rate, current roses showing the variability of the current and predominant current direction and rate.

In day-to-day navigation the predominant and current rose charts are used in conjunction. The predominant chart shows the direction of the current chiefly recorded and its average rate, whilst the degree of probability that the current direction shown on the chart will be the one experienced is indicated by the thickness of the arrows. In no area is there a 100% certainty of the direction of the current. The navigator can form an idea of the likely accuracy of his estimate by consulting the current roses which show the maximum rate of current ever to have been observed in the region and also the extent to which the direction has been known to differ from the predominant one.

He must then take into account the effect of the winds over the last few days. Ocean currents arise from temperature and salinity variations and from the effects of wind, but their variability in the open ocean arises almost entirely from variations in the strength or direction of the wind. Even so the formation of wind-induced currents is very complex and is not fully understood. A time lag exists between the onset of wind and the maximum current resulting from it. There is also a time constant of decay over current once it has been established. These times are for practical purposes of the order of one day. Unfortunately the current sets at an angle to the direction of the wind (30-40 degrees to the right in the northern hemisphere, to the left in the southern hemisphere) on account of the Coriolis force which will be mentioned again later; it is bound up with the rotation of the earth and consequently there is a latitude variation. Again the proximity of land masses has an effect. The Gulf Stream for example owes its origin to the head of water built up in the Gulf of Mexico by the equatorial currents of the Atlantic Ocean. As a result of these complications there is no part of the ocean where the current may not attain a rate of one knot, and in most regions this is exceeded at times. The charts show that the observed rate can exceed the predominant by a factor of two or even more. Rates exceeding two knots are observed over considerable areas, whilst rates exceeding three knots occur in many places. Examples are the East African coast current which reaches seven knots and the Kuro Shio and Agulhas current which reaches five knots. Yet there are no regions where rates less than ¼ of a knot do not occasionally occur. In the open ocean the error in estimating the current may well be one or more knots, and in coastal regions tides lead to even greater errors.

The tidal system in the waters surrounding the British Isles, though complicated, has been well investigated, but in other parts of the world observations are fewer and in many areas the tidal stream pattern is even more complicated than that around the British Isles. Over all, however, errors in estimating tidal stream are generally less than those in estimating the currents due to wind.

The figures so far given refer to surface currents where most of the observations have so far been made. Methods of measuring subsurface currents are now being developed. Measurements have been made of the electrical potentials due to motion of the water in certain regions through the earth's magnetic field but the results are difficult to interpret. More success is being achieved with a system devised by Swallow, of the National Institute of Oceanography, which employs an acoustic responder set to drift with the current at any required depth, but the oceans are very large and very deep and the information gained to date is very scanty.

Calibration on the Measured Mile

Owing to the varying flow pattern around the ship, it is necessary to calibrate the log *in situ*. That is the ship must run at various speeds and the log reading taken so that a correction curve can be deduced. In the past this has been carried out over the measured mile where the log is calibrated and ship's speed is correlated with propeller revolutions and power. A disadvantage of the measured mile is that the course must be sufficiently close to shore to permit observa-

Table I

Course	Ship's speed (knots)	Time for 100 miles (hours)	Probable errors (miles)							
			Log error	Compass error	Currents, drift and tides	Leeway				
						Wind force 10	Wind force 8	Wind force 6	Wind force 4	Wind force 2
Steady	8	12·5	1·3	0·3	4	11	8	5	3	1
	16	6·25	1·3	0·3	2	6	4	3	1	1
	32	3·2	1·3	0·3	1	3	2	1	1	0
Typical Zig-zag	8	14·7	1·3	0·3	5	10	7	5	3	1
	16	7·4	1·3	0·3	3	5	4	2	1	1
	32	3·7	1·3	0·3	1	3	2	1	1	0

Probable errors after travelling 100 miles

tion of the transit of the vessel past markers on shore at each end of the mile. Thus the depth of water is limited, tidal currents are encountered, visibility conditions must be good, and sea room for turns is restricted.

A method of overcoming these limitations has been developed by Hastings-Raydist Incorporated, Hampton, Virginia, called the Raydist Range System. In its simplest form, continuous wave transmitters emit continuous radio signals which differ from each other by audio frequencies. These heterodyne audio frequencies are received at two or more points. By comparing the phase of the signal as received at the various points, accurate distance determinations can be made. Determination of precise distances to several points allows position to be determined either in a plane or in three dimensions. The equipment on board ship includes a C.W. transmitter, the Raydist Navigator and phase meters to display positions together with a chart recorder. With the assistance of two shore stations, ship's position can be determined to within one metre at distances up to 200 km from shore. Alternatively, using the shore station and a free floating buoy, ship's speed relative to the water can be determined with a similar order of accuracy.

Accuracy of Log and Compass

An attempt can now be made to answer the question "To what extent is it worth while to increase the accuracy of speed and direction measuring equipment?" Navigational accuracy is limited chiefly by leeway (surface ships) and the movement of water over the sea bed. Although the accuracy depends also on the extent to which the log is affected during turns, the errors from this cause are relatively small. Some probable errors are presented in Table 1. The following errors have been taken: log 1·3%, compass 0·17 degrees, currents, tides, etc., 0·3 knots. Leeway errors are based on the estimate that leeway is proportional to wind component across the course, the constant of proportionality having a mean value of 0·075 and standard deviation 0·025. This is consistent with the estimates made by a number of experienced navigators with whom the problem has been discussed by the writer and with the occurrence of errors of up to one knot in some circumstances.

Examination of the table shows that in the face of likely errors due to leeway and water movement, little is to be gained in installing a log of greater inherent accuracy than those in use except for special operations. It should be remembered that the errors presented are probable errors so that they should be compounded by adding their squares. In wind force 4 for example and a ship's speed of 8 knots a probable error due to all causes would be $\sqrt{1{\cdot}3^2 + 0{\cdot}3^2 + 4^2 + 3^2} = 5{\cdot}2$ miles per 100 miles travelled. If the log error and the compass error were eliminated the error would be $\sqrt{4^2 + 3^2} = 5{\cdot}0$ miles. Thus even when allowance is made for a considerable margin of error in the estimates on which a table is based, it is evident that the increase in accuracy of navigation brought about by a more accurate log or compass is not likely to be very great.

This conclusion, it should be emphasised, applies to merchant vessels in general. It would be unwise to deny the possibility of applying more accurate equipment in special cases such as submarine navigation in areas where water movement is known to be slight. With this proviso, the development of log and compass equipment for merchant vessels should aim more at ease of maintenance and reliability that at greater accuracy.

Inertial Navigation

The availability of radio aids to navigation has so far been left out of the argument. These now can be made to cover the whole globe with high accuracy but it is significant that the word "aid" is used. In the last resort the navigator must be able to operate with no outside assistance. One system which has not so far been mentioned, however, requires no such assistance, and is known as "SINS" (Ship's Inertial Navigation System). This system makes use of the property of a gyroscope to maintain its axis fixed in space.

The principles of inertial navigation are simple and have been known for many years, but the problems involved in putting them into practice are extremely formidable. Only in the last few years has equipment been developed with accuracies even approaching the necessary order. Basically the requirement is to determine three axes mutually at right angles and "fixed in space". Then if the components of the acceleration of a

body are measured along these three axes, the components of velocity can be determined by integration, provided that the initial velocity is known. By integration of the velocities, the components of displacements can be determined, thus determining the motion of the body in "space". Since a free gyroscope maintains its axis of rotation fixed in space (subject to instrument imperfections such as bearing friction, lack of balance, etc.), it should be possible to define our three axes by means of gyros. And although the accelerations cannot be determined directly without reference to some fixed point (the directions of the axes are not sufficient; their point of interception must be known as well), it is possible to carry a mass and measure the forces acting on the mass and so determine its accelerations from the simple equation: force equals mass multiplied by acceleration.

In principle, therefore, given instruments of the necessary perfection, the track of the ship in space can be computed; and since the astronomers can tell us the track in space of any point on the earth's surface, all that is necessary is (theoretically) to subtract the two and the answer is the position of the ship on the earth's surface.

The advantages of such a system are firstly that it can be made completely automatic. The output of the system consists of two quantities, latitude and longitude. Secondly the system is undetectable. The ship makes no radio transmissions such as are required by ship's radar and no acoustic transmissions such as are generated by echo sounding or asdic equipment. This is an important advantage to naval ships, as is the fact that the system cannot be jammed (for there is no dependence on ground based aids such as radio transmitters). Finally, the system can be applied universally (theoretically); it can be employed by ship, submarine, aircraft, land vehicle, ballistic missile or space ship.

When the mathematics of inertial guidance are examined a fundamental limitation becomes apparent. It is of philosophical rather than practical significance and stems from relativity. Mention has been made of "space". Newton believed it could be defined and the motions of the earth, the sun and the stars all determined relative to it. Many attempts were made to establish the earth's motion through this fixed space but they all failed, as did later the experiments to determine the "aether drift" by measuring the velocity of light in two directions at right angles. The theory of relativity tells us that no frame of reference is absolutely at rest. If axes are chosen which are fixed in direction relative to the fixed stars and if the centre of gravity of the solar system is taken as origin, then our mechanical observations (motion of bodies on the earth's surface, provided they are not too small or going too fast and motions of the planets) can be explained in terms of gravitational forces. This is adequate for our purposes, but it means that motion in "fixed space" has no meaning; we must choose our "space". For this reason a free gyroscope can demonstrate the rotation of the earth relative to any chosen part of the universe but not to that of the universe itself, for this is meaningless.

Having accepted this limitation, we have to transfer our frame of reference from the centre of the solar system to some chosen point on the earth's surface. When this is done it is readily seen that our new axes are rotating relative to the old (very nearly once per day). But a body moving in a circle experiences an acceleration towards the centre of the circle, and so, if the body has a finite mass, a force must be applied to it in the same direction, i.e., toward the centre of the circle. But the rate of rotation depends on our choice of axes; so evidently the force is not an absolute thing but is relative to the frame of reference. Coming down to earth, rotation of the earth applies a centrifugal force to any body at rest relative to the earth's surface. What is more, if the body moves over the earth's surface, it experiences another force, which is known as a Coriolis force. Because of this force (which is required by conservation of angular momentum) any body moving in the Northern hemisphere tends to swerve to the right and any body moving in the Southern hemisphere, to the left. Terrestrial inertial navigation systems must therefore be corrected for the centrifugal and Coriolis forces.

This can be done, and thus the first requirement is for a stable platform which does not rotate in any direction relative to "space" as defined by the fixed stars. A known mass is mounted on this platform; and the second requirement is to measure the three forces required to keep the mass in the same position on the platform. The third requirement is to determine the angle between the platform and the horizontal, for the mass is subject to the force of gravity in addition to the forces which have been measured and it is necessary to know the direction in which gravity acts relative to the stable platform.

From the known forces acting on the mass, its accelerations in the directions of the chosen axes can be deduced. The fourth requirement is to integrate these accelerations twice to give displacements. The velocities (obtained by a stage of integration) are required for computation of the Coriolis force correction. In practice the integration and the corrections arising from transformation of axes are not necessarily done in this order, though the order in which they are done does not affect the principle.

Apparatus used in Inertial Systems

It remains to describe briefly the techniques used in maintaining the stabilised platform and in measuring the forces. Stabilisation is achieved by means of three special gyroscopes mounted on the platform, each of which detects rotation about one of the chosen or "inertial" axes. The platform is mounted on gimbals which are driven by servo systems controlled from the gyros. These correct any tendency to drift and their sensitivity is such that rotation of as little as 1/200 of a degree is sufficient to actuate them. The gyros used for this purpose are known as "single axis rate integrating" and were developed by Draper, of the Massachusetts Institute of Technology. In these gyroscopes the eccentric weight employed in the gravity control types is replaced by a dashpot. If any rotation occurs about the appropriate axis the gyroscope begins to precess, and since the dashpot generates a restraining force proportional to the rate of precession, by suitable choice of constants the rate of precession can be made equal

to the rate of rotation about the inertial axis. The rate of precession is picked off and the signal employed via the servo system to return the platform to its original direction.

The precision of present day rate integrating gyros is such that drift rates less than 0·5 degrees per hour can be achieved with even small instruments whilst with larger instruments the performance may be as good as 0·1 degree per hour. To achieve this performance the rotor must be subjected to the minimum of frictional forces. It is in practice encased in a float which is neutrally buoyant in a heavy liquid. An idea of the mechanical perfection required can be gained from the fact that a gyroscope of 10^7 grams cm^2 inertia in a field of 1 *g* will drift at the rate of 0·1 degree per hour if the rotor is off balance by only 10^{-6} of an inch (one sixteenth of the wavelength of blue light).

There are a number of alternative ways of measuring the forces. The forces may be provided by the interaction of a magnet with an electric current. Changes of position are detected and the current increased or decreased to counteract them. The magnitude of the current is then a measure of the force required. Again the mass may be held by means of wires which are maintained in vibration. The frequency of vibration is a simple function of the tension in the wire. (The system has already given good service in portable gravimeters capable of measuring extremely small variations in the earth's gravitational field.) Finally, a suitably arranged gyroscope with an offset mass can be employed. The rate of precession of the gyro is then proportional to the acceleration and thus the gyro axis turns through an angle which is proportional to the velocity and one further integration gives the required displacement.

It will be appreciated that the accuracies must be of a very high order, and moreover the measurements must cover a range of values of at least 10,000 to 1 with good linearity. A feature of the errors involved in measurement of the magnitudes and the directions of the acceleration is that both lead to navigation errors which increase with time independently of speed: whether the vehicle is travelling at two knots or 20,000 knots the position error after an hour's journey is the same. Consequently inertial guidance is at its best in ballistic missiles and at a grave handicap in slow vehicles such as submarines. On the other hand the submarine has an advantage (at least over surface vessels) since, when submerged, it is immune from rolling and pitching. Steady course and constant speed naturally give the system the best chance.

Errors increase with time, moreover, at an increasing rate. Given a steady rate of drift in direction measurement, position errors accumulate at right angles to the course steered, at a rate proportional to time squared. With a drift rate of 0·1 degrees per hour and a speed of 20 knots, the position error after one hour is 36 yards. After five hours the error is nearly half a mile, after 10 hours 1·75 miles and after 100 hours 175 miles. Acceleration errors also increase the square of time, and to match the drift rate of 0·1 degree per hour, acceleration must be measured with an accuracy of $0{\cdot}5 \times 10^{-6}g$.

Inertial systems thus require a periodic check, and proposals have been put forward for combining them with astronomical and radar systems. The advantage of such a combination is that the inertial system can be used to cover periods during which radio or astronomical data are not available.

Acknowledgments

The writer is indebted to many firms and individuals for the help he has received in preparing this article. Firms who have provided information about the equipment they manufacture are mentioned by name in the text, whilst experts who have been consulted are: Mr. Maples (on present day logs), Mr. Wassell (on gyro-compasses), Mr. Yearling (on ship's turning), Mr. Barlow (on the measurement of ocean currents) and Cdr. Hoare and Cdr. Rodwell (on leeway estimation). A paper by H. Hoppe, of the Hamburg Experiment Tank, Ships' Speed Meters, has been consulted as have papers by A. Stratton, D. E. Adams, and H. M. Briscoe on Inertial Navigation. Historical notes were supplied by Thomas Walker & Son Ltd. A detailed account of the development of the common and Dutchman's logs is given in the Journal of the Institute of Navigation, **9** (1), Jan., 1956, by E. W. Walters, who gives evidence which suggests that the Dutchman's log may in fact have followed and not preceded the common log.

BOOK REVIEWS

Directory of Opportunities for Qualified Men. Preface by Sir Miles Thomas. 1959. 116 *pp. Cornmarket Press Ltd.* 8s. 6d.

The purpose of this annual reference book is to provide men and women, who have obtained professional or technical qualifications, with a clear picture of the openings available to them during the coming year. The reference section gives detailed information about commercial and industrial organisations and government departments, the training each will offer and the prospects for promotion. A classified index summarises in tabular form information about the size of the organisations, whether men or women are employed, and the areas in which employment is offered.

Year Book of the Physical Society. 1958. 106 *pp. The Physical Society.*

The special lectures delivered before the Society are given in full. These lectures are as follows:—

42nd Guthrie Lecture. Experimental tests of quantum electrodynamics.

Opening of the 42nd Physical Society Exhibition. Speech by the President.

Discourses given at the 42nd Physical Society Exhibition.

- Goethe's colour experiments.
- Some uses of physics in archaeology.
- Some recent investigations with aircraft on the physics of clouds and rain.

35th Duddell Medal Address. Measurement of the thickness of the helium film.

9th Charles Chree Lecture. The secular variation of the earth's magnetic field.

13th Holweck Lecture. Spin temperature.

14th Charles Vernon Boys Prize Address. Development of bubble chambers and some recent bubble chamber results on elementary particle physics.

SEVENTH SIMA CONVENTION

Introduction

THE Seventh Annual Convention of the Scientific Instrument Manufacturers' Association was held at Harrogate from 6th to 9th November, 1958.

The convention this year assumed a rather different form in that it was mainly devoted to frank discussions between manufacturers and users. Representatives from four of the country's major industries were present. The industries were: iron and steel, textiles and fibres, oils and chemicals, and fuel and power. Each industry was invited to discuss its problems under four headings: instruction manuals, installation and servicing, laboratory instrumentation, plant instrumentation and future trends. The salient points arising from the discussions are given below.

Instruction Manuals, Installation and Servicing

Iron and Steel Industries

1. Instruction manuals must be written in plain English. In this connection it is felt that although the initial information must come from the technical staff associated with the development, the final version should be produced by a technical writer. The latter would normally be attached to the publicity department. (See also No. 5 under Oils and Chemicals Industries and No. 2 under Textiles and Fibres Industries.)
2. All diagrams should conform to relevant British Standards. Block diagrams, useful in explaining the principle of an instrument, seem to be omitted in too many manuals.
3. The basic principle on which the instrument works should be stated, followed by a description of the instrument. The relative importance of each step in the operation could be emphasised.
4. On complex equipments a useful procedure would be to deliver all working instructions two or three months in advance of installation.
5. It is realised that good maintenance instructions are expensive to produce, but it would appear that a number of users are prepared to pay a reasonable sum for these. (See No. 6 under Oils and Chemicals Industries.)

Textiles and Fibres Industries

1. It is suggested that manuals be prepared in some form of loose leaf design so that revisions can be inserted easily.
2. Initial information should come from the technical staff concerned with the development, but the final product should be prepared by a technical writer. Before publication it should be read by personnel of similar calibre to the user.
3. It may prove advantageous to divide the manual into two sections: one for operating instructions, and the other for maintenance.
4. If a charge is made for manuals it is suggested that this be a charge on overheads and not on the actual instrument.
5. The plant instrument operator (and possibly the plant engineer) should receive personal instruction from the instrument manufacturer's engineer.
6. Some users prefer the cost of installation and commissioning to be shown separately on any agreement. If a regular servicing arrangement is available it should be mentioned at the initial stages and not after the equipment has been installed.
7. Specialist concerns are in existence who maintain the instruments common to one industry. These could be of great benefit to a small manufacturer.

Oils and Chemicals Industries

1. Manuals should be written in plain English, an obvious requirement, but not always carried out.
2. All circuit diagrams should bear values and ratings of components.
3. Standardised nomenclature should be used wherever possible.
4. Parts lists and list of recommended spares should be included.
5. Although the initial information must come from the development staff, the final version must be the work of a technical writer. Before publication, it should be handed to a relatively unskilled person and a check made whether he can perform all the operations specified purely by reading the manual.
6. A number of users appear to be prepared to pay for a manual.

Fuel and Power

1. It is realised that the preparation of manuals can be an expensive affair. It is felt, however, that users would be prepared to pay a little more for an equipment and have really first class instructions. The extra cost could easily be recovered in easier maintenance.
2. Adequate circuit diagrams must be included and symbols should be in accordance with the relevant British Standard (B.S.530 was quoted at the Convention). Values and ratings of components should be specified.
3. A small plastic sheet with a circuit diagram could very well be included in the instrument itself.
4. Accessibility is important from the servicing point of view, and plug-in components have much to recommend them.
5. A possibility exists of establishing a group service agent who could service the instruments of a group of manufacturers. This might involve specialised and expensive test gear. (See No. 7 under Textiles and Fibres Industries.)

Laboratory Instrumentation

Iron and Steel Industries

1. It is desirable for manufacturers to quote a price in their first reply to an enquiry, approximate though it may be.
2. The possibility of hiring out the larger and higher priced equipment, in a similar fashion to computers, could be examined. The equipments envisaged are those selling at £10,000 to £20,000.
3. Training courses for operators at firm's works on equipment before delivery should include second and third operators, particularly where a shift basis is involved.
4. It is desirable to use steel components for vacuum equipment (as opposed to glass) wherever possible.
5. Small high frequency furnaces for rapid determination of carbon and sulphur in steel require further development.

Textiles and Fibres Industries

1. The necessity for adequate instrumentation is growing rapidly. One reason for this is that 60% of man-made fibres goes to industry for specialised purposes. This calls for reasonably tight specifications and enables test procedures to be rather more easily defined than in the case of the domestic field. Instruments can be used more readily.
2. Closer links are urged between the various textile research associations and manufacturers, and the Engineering Equipment Users' Association.

Oils and Chemicals Industries

Many of the points given below relate to the findings of an extremely large soap manufacturer.

1. Because of the lack of a satisfactory new instrument, an old Lovibond tintometer is being used to determine the colour of liquids.
2. The "ruggedness" of pH instruments appears to be insufficient.
3. Measurement and control of moisture content is important since the end product is sold by weight. No really satisfactory equipment has been found.
4. The thermostatic control of water baths, in many cases, does not fulfil requirements and a number of thermostats have been purchased abroad.

Fuel and Power Industries

1. Standardisation is desirable wherever possible and possibly B.S.I.R.A. could produce draft model specifications for a number of instruments.
2. Certain instruments are imported at the moment. These include special colorimeters, viscometers, balances in the kilogram range and thickness gauges.
3. In choosing suitable exhibitions for the display of a new instrument, that of the Physical Society is very favourably regarded.
4. Points in new instruments which deserve praise are plug-in units, particularly the encapsulated types, and easy access to electronic and mechanical components.
5. Instances have been noted of insufficient inspection or no inspection before dispatch.

Plant Instrumentation

Iron and Steel Industries

1. On a moving strip of steel, hot or cold, emerging from the rolling mills, measurements of a wide variety of parameters are needed. These are thickness, width, temper, surface finish, thickness of tin coating and presence of laminations. X-ray fluorescence may be useful in solving some of the problems involved, but the conditions in rolling mills are far from ideal and will require special study. Again, the demand for such equipment is relatively small—five or six for this country. Strip width is the only problem in which real progress has been made.
2. Closer co-operation is urged between SIMA and the British Iron and Steel Research Association, particularly in view of the fact that development in any of the fields suggested above could involve a financial risk.

Textiles and Fibres Industries

1. Instruments must be simple and reliable.
2. Closer collaboration should be maintained between instrument manufacturers, the relevant research associations and textile machinery manufacturers.
3. The proposal to hire instruments would seem to be acceptable to the textile industry.

Oils and Chemicals Industries

1. These industries are moving from the stage of measuring and controlling normal physical conditions such as temperature, pressure, liquid level, etc., to a complete plant analysis. This would result in an overall feedback system controlling the actual plant.
2. A long delay appears to exist in this country (compared with others) between the conception of an idea and the appearance of an instrument on the plant.
3. The creation of an evaluation service by the instrument industry is viewed with favour. This could obviate duplication of effort and raise the prestige of the industry.
4. Flame-proofing and intrinsically safe instruments do not appear to have been examined thoroughly, and here an opportunity seems to exist for collaboration between SIMA and the Engineering Equipment Users' Association.

Fuel and Power Industries

1. Reliability is here an over-riding requirement. A single trip of a reactor could cost around £10,000, and a policy has been introduced of triplicating all important instruments, and feeding them by cables passing along different routes.
2. All instruments must involve the "fail-safe" principle. An instrument failure, whenever possible, should be distinguished from a plant failure.
3. Manufacturers will have new problems to solve due to the radioactive nature of the processes.
4. The immense amount of information presented on instrument panels in a reactor power station (some

panels may be 80 ft long) points towards data processing and some form of computer control.
5. The reasons for instrument failure in service could be of benefit to the manufacturer.
6. In general, indicators should be free from distracting influences such as views of the mechanism through the instrument window.
7. Standardisation of instruments and components is highly desirable.

Future Trends

Iron and Steel Industries

1. In the United Kingdom, the blast furnace is likely to be responsible for the majority of iron manufacture, and the open hearth process for steel.
2. Special problems involve roof temperature measurement in the open hearth furnace and temperature measurement at the bottom of the blast furnace. The latter cannot be carried out by microwave methods, contrary to some opinions held.
3. Detecting elements are used over long periods and must be reliable. It is suggested that two or three are used together to reduce risk of failure.
4. Moisture content of iron ore is another problem. A neutron method is suggested. (This has been used satisfactorily for sand and soil.)
5. Faster analytical equipment is needed, particularly by X-ray fluorescence and general spectrographic methods.
6. The measurement of the thickness of refractory walls has been tried by using radioactive cobalt and measuring the rate of disappearance. This has not been wholly successful and a satisfactory method of measuring wall thickness from the outside is needed.

Textiles and Fibres Industries

1. New fibres call for instruments to assist in translating the laboratory results to the mill in a much quicker time than can be performed by empirical methods.
2. Typical problems unsolved are a yarn regularity tester and a yarn tensioning tester. Both must operate without affecting the fibre, however thin.
3. Drape, lustre and colour are three fields in which instrumentation requires further development.

Oils and Chemicals Industries

1. Gas chromatography has speeded up analytical methods.
2. Ultrasonic pattern flow meters are not yet available in this country.
3. The study of plant operating conditions can be materially assisted by the use of data loggers, portable or otherwise. Later the information can be analysed by computers and eventually be the basis for the control of a plant using computer methods.
4. Priorities in instrument design are firstly dependability followed by reproducibility and accuracy.
5. The use of pressurised cubicles can reduce the necessity for flameproofing or intrinsically safe instruments, but these have limitations from the maintenance standpoint.
6. The subject of low power operation under intrinsically safe conditions needs to be investigated.
7. Transistors could be a means of reducing the power level of a circuit.

Fuel and Power Industries

1. There is apparently a large field for instruments concerned with safety conditions in a mine. Methanometers are one example; carbon monoxide meters are another. Temperature and humidity measurement are other problems in instrumentation.
2. Another large field seems to lie in instruments to measure certain functions involved in coal cutting itself.
3. The replacement of pneumatically-operated systems by electrical ones is satisfactory above ground, but instrumentation below ground is a major problem.

The ACE Computer

ACE, one of the world's largest and fastest electronic computing machines, recently began operating at the National Physical Laboratory.

Very fast computers are required for many problems of which design calculations for high-speed aircraft and nuclear reactors are typical examples. The emphasis in the N.P.L.'s use of ACE will, however, be into the general methods by which computations such as these can be carried out.

ACE is the end-product of research which began at the National Physical Laboratory at the end of the war. In 1945 the late Dr. A. M. Turing, F.R.S., joined the staff of the mathematics division at N.P.L. and in the early post-war years he produced, with his collaborators, a logical design for a computer intended to carry some of the load of numerical calculation. He called it the Automatic Computing Engine, or ACE.

In 1947 a special section, now the Control Mechanisms and Electronics Division, was set up to carry out the development of the machine. It was, however, thought unwise to attempt to build so large and complex a machine in one step, so it was decided to make first a pilot model of considerably smaller power and capacity.

Thus, a pilot-model ACE, only one-sixth of the size of the present machine, was built to investigate the engineering problems which would arise in the full-scale machine. It was completed in 1951 and during its five-year life at N.P.L. it carried out a considerable amount of work, including extensive calculations to discover the cause of failure in the early Comet. It was, in fact, the pilot-model which led to the commercial production of the English Electric DEUCE computer. Moreover, it provided the team of mathematicians, logical designers, electronic engineers and mechanical

engineers with the essential experience to undertake the more ambitious full-scale ACE project.

The numbers and instructions have 48 binary digits (equivalent to 14 decimal digits). The working store consists of 800 words, and the backing store of four magnetic drums will contain a total of 32,768 words.

Mercury delay lines and magnetic drums are used for the storage of numerical data and instruction sequences, and both punched card and magnetic tape equipment are provided for input and output.

The magnetic drums rotate at 12,000 r.p.m. so accurately that the arrival at a given point of a magnetic spot one hundredth of an inch in length, travelling at 200 miles per hour, is timed to a millionth of a second. An idea of the speed of ACE can be gained from the fact that these drums are the slowest part of its number store.

ACE has three forms of storage. The largest part of the store consists of four magnetic drums which store a total of 32,768 numbers. The access to these numbers is limited by the need to wait for the drum to revolve, and may take up to seven milliseconds. These drums are used by the computer for the large mass of data that it may not want quickly.

For more rapid access, a mercury delay line store of 768 numbers is employed. The time required for access to these is up to one thousandth of a second.

The most rapid access store consists of short delay lines storing one, two or four numbers each. These are used for the small group of numbers that the computer is using for a short while.

The ACE instructions specify the addresses, the locations in the store, of two numbers to be operated on, the operation, and the addresses of the desired destination of the result and the location of the next instruction. Thus four addresses are used, and all four accesses occur nearly simultaneously. In addition, multiplication and division occur in separate, autonomous devices, so that they can occur simultaneously with other operations.

In many cases, the computer will average 15,000 operations per second, each involving the extraction of two operands (numbers to be operated on), storing the result and extracting the next instruction.

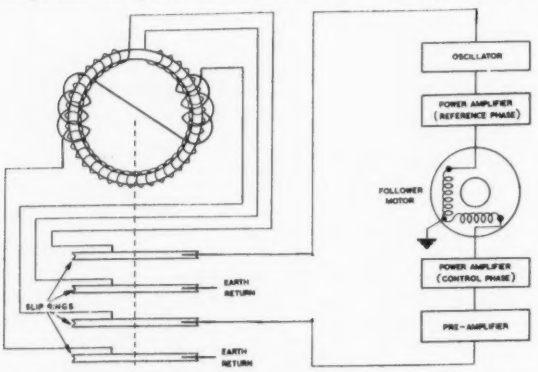
Input and output is by punched cards. Magnetic tapes will be fitted later, but will be used as an extension to the store. The input speed from cards will be 7,000 binary digits per second, with a rate of 450 cards per minute punched in binary.

A SERVO-OPERATED COMPASS REPEATER

Introduction

IT is fundamental that optimum magnetic compass efficiency is only assured by placing the instrument at the position where it is least affected by the magnetic influences of the ship. Since other practical considerations, such as accessibility and all-round vision, must also be taken into account the conventional "monkey island" site generally satisfies these conditions. It is desirable, however, that the high standard of directional efficiency thus achieved should be made available at other stations where unavoidable magnetic influences may preclude optimum compass performance.

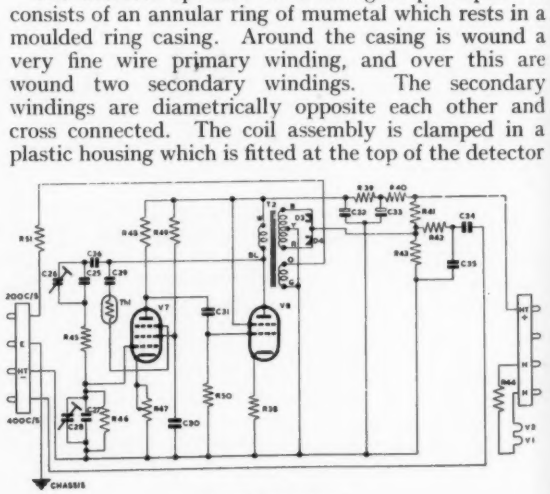
The equipment comprises a conventional standard magnetic compass with a detector unit fitted to the underside of the bowl. This unit detects the ship's movement about the compass card and a servo motor keeps the detector constantly aligned with the magnetic system. The same servo motor is connected to a transmitting device, which controls various repeaters throughout the ship.



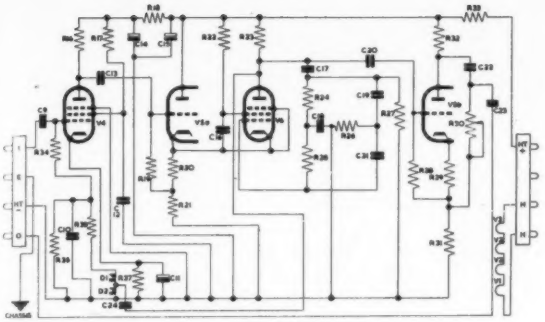
Basic circuit.

Principle of Operation

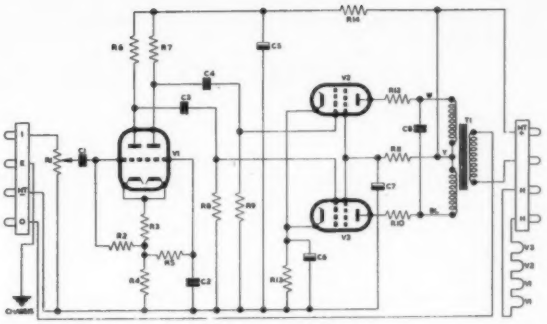
The detector operates on a flux gate principle. It consists of an annular ring of mumetal which rests in a moulded ring casing. Around the casing is wound a very fine wire primary winding, and over this are wound two secondary windings. The secondary windings are diametrically opposite each other and cross connected. The coil assembly is clamped in a plastic housing which is fitted at the top of the detector



Oscillator circuit.



Pre-amplifier.



Power amplifier.

unit assembly. On the underside of the housing are fitted four slip-rings.

Consider the detector initially in the null position.

In operation the primary coil is energised to a state of saturation by a potential of 2-3 volts at 200 c/s, obtained from the oscillator in the amplifier unit. Due to the saturation of the mumetal the flux pattern is distorted with the result that the frequency is doubled, giving an output in the secondary winding at 400 c/s. No current flows, however, until the compass magnet moves away from the null point, i.e., when the coil system is in line with the N-S points of the compass magnet. Immediately the magnet moves away from the null a voltage is generated at approximately 5-10 mV 400 c/s per degree of rotation. This voltage will continue to rise until the 90° position is reached. By continuing the rotation of the magnet beyond the 90° position the voltage will fall until it reaches zero at 180°. The transmitter can never become out of phase accidentally, however, since:—

(i) The detector will hunt at the 180° position seeking to find the true null point and

(ii) it is impossible to turn the ship faster than the speed at which the detector will follow.

Observe, however, the effect on the servo motor when an out-of-balance voltage is generated.

The motor is a two-phase servo type. It will develop full torque when both its windings are energised at 26 V 400 c/s. The reference phase is constantly energised at this frequency by the output from the reference phase power amplifier which amplifies the oscillator signal. The control phase is only energised when a voltage is created in the system by the movement of the compass card.

The motor is mechanically connected to the detector unit by a "Sun and Planet" gear system, and also directly geared to the transmitter unit. The ratio between the motor and the transmitter is 35 : 1, and 90 : 1 between the transmitter and detector unit.

Any movement of the motor shaft due to an unbalance signal tends to re-align the detector coil system with the compass magnet, and at the same time operate the repeater to give the new bearing. The motor operates until the null position is reached, i.e., coil and magnet are in alignment.

Oscillator

The oscillator gives two frequency outputs, one at 200 c/s and the other at 400 c/s. It has two valves and is resistor/capacitance coupled. Valve V7(6059) is an oscillator and V8(G/50C5) is a power output valve which also provides the feedback for the oscillator network.

Two capacitors (C26 and C28) balance two networks to provide a tuned frequency at 200 c/s.

A thermistor is incorporated in the V7 stage. It has two purposes; one is to limit the gain of the pentode so that it only just oscillates, and the other is to act as a stabiliser when the mains voltage fluctuates.

The output from V8(G/50C5) is fed to the transformer T2. The transformer has two secondary windings. One of these is the 200 c/s winding, whilst the other is a centre-tapped winding and feeds two diodes which form part of the frequency doubler network, thus providing a second harmonic at 400 c/s.

The 200 c/s signal is used to energise the primary winding of the flux gate detector and the 400 c/s signal is injected into the reference phase power amplifier.

Pre-amplifier

A 400 c/s signal is fed into the first stage V4 from the flux gate. The valve is a medium gain pentode 6059. A feedback circuit from the second half of V5b(6060) provides a gain limiting device, and by means of two diodes, D1 and D2, rectifies and changes the bias on valve V4. This is necessary to prevent overloading the amplifier when the detector is a few degrees away from the null point. From V4 the signal passes to the triode V5a. This is a cathode follower stage which has negligible gain; its purpose is to provide the correct matching for valve V6(6059) which is fed by cathode injection. The V6 stage contains the tuned feedback network which consists of high stability components R24, R25, R26, C18, C19 and C21. Output from valve V6 is fed into the V5b stage which provides control by means of R30 for adjusting the phase of the supply to the control phase power amplifier, and thence to the motor winding.

Power Amplifiers

These are identical.

The signal is injected via R1 to the first valve V1 (6060) which is a phase splitter. The signal then passes to a push-pull output stage formed by two tetrodes V2 and V3(G/50C5). These feed into an output transformer, the secondary of which feeds the relevant phase.

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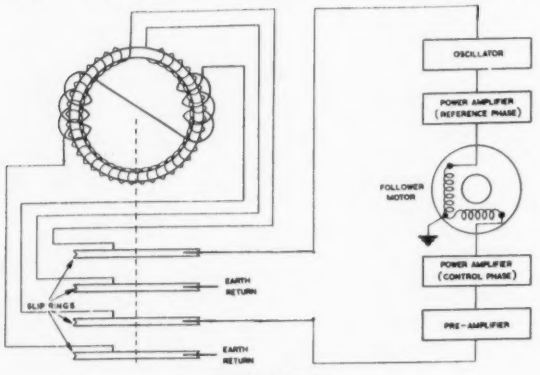

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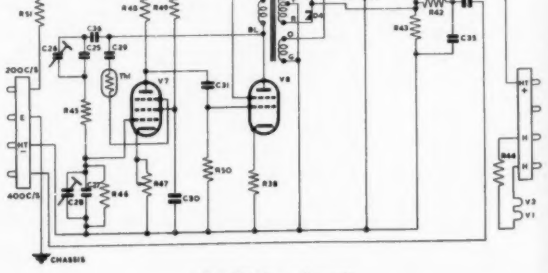

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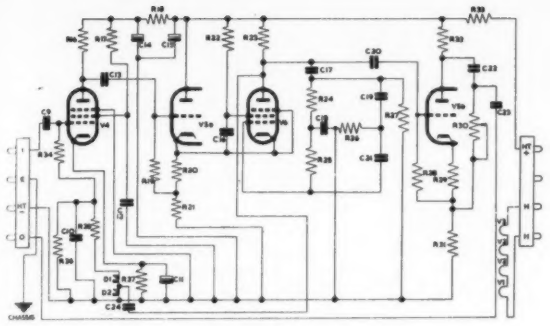

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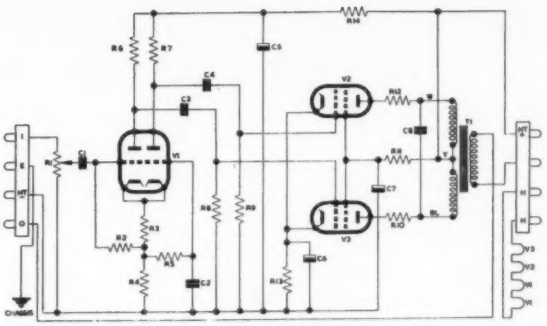

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The 200 c/s signal is used to energise the primary winding of the flux gate detector and the 400 c/s signal is injected into the reference phase power amplifier.

Pre-amplifier

A 400 c/s signal is fed into the first stage V4 from the flux gate. The valve is a medium gain pentode 6059. A feedback circuit from the second half of V5b(6060) provides a gain limiting device, and by means of two diodes, D1 and D2, rectifies and changes the bias on valve V4. This is necessary to prevent overloading the amplifier when the detector is a few degrees away from the null point. From V4 the signal passes to the triode V5a. This is a cathode follower stage which has negligible gain; its purpose is to provide the correct matching for valve V6(6059) which is fed by cathode injection. The V6 stage contains the tuned feedback network which consists of high stability components R24, R25, R26, C18, C19 and C21. Output from valve V6 is fed into the V5b stage which provides control by means of R30 for adjusting the phase of the supply to the control phase power amplifier, and thence to the motor winding.

Power Amplifiers

These are identical.

The signal is injected via R1 to the first valve V1 (6060) which is a phase splitter. The signal then passes to a push-pull output stage formed by two tetrodes V2 and V3(G/50C5). These feed into an output transformer, the secondary of which feeds the relevant phase.

THE BRITISH SONCEBOZ CO. LTD.

All instruments are built up from components or parts which may either be produced by the instrument manufacturer himself or obtained from a firm specialising in the production of the relevant components. Obviously, no hard and fast rule may be established since so many factors such as quality, costs and deliveries come into the question. But there are many products, particularly where precision work is involved, which can advantageously be made by a component firm. Such a concern is the British Sonceboz Co. Ltd.

The firm began in this country some twenty-five years ago when Mr. Pfister introduced the first gas light controllers. During the war the firm was engaged in the production of rate-of-climb indicators and boost gauges. After the war it seemed opportune to widen the range of products manufactured in this country. The firm had a long experience in precision engineering to draw upon from the Société Industrielle de Sonceboz in Switzerland, and pressure gauge movements, clock movements, etc., began to appear from the factory at Gorst Road, Park Royal, London. The firm soon established a reputation for quality products at competitive prices and the Gorst Road premises became inadequate. A move was made, therefore, about two years ago, to a new factory in Victoria Road, South Ruislip. This factory has about 12,000 sq. ft devoted to the manufacturing shops and is fronted by the normal office block. Plans are in hand at the moment to extend the factory area to cover a new range of components and meters.

The factory area is divided into a machine shop, an assembly shop for pressure gauge movements, an assembly shop for clock movements especially of the recording drum pattern, general stores, tool room and so on. The layout is so arranged that a production flow takes place from raw material input to dispatch of finished product.

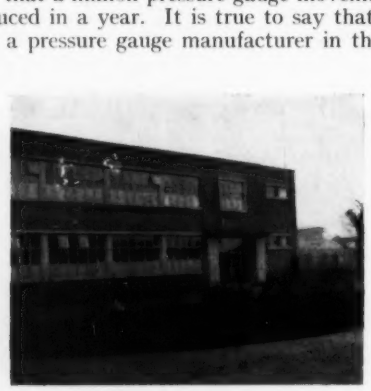
Some idea of the firm's capacity can be gauged from the fact that a million pressure gauge movements may be produced in a year. It is true to say that there is scarcely a pressure gauge manufacturer in the instrument industry that does not use these movements today. Not only must these and other components be produced by precision methods (tolerances for some holes, for example, are $\frac{1}{100}$ part of a millimetre) but the price must be competitive not only against other British manufacturers, but against foreign concerns, particularly those of Germany. One reason undoubtedly for the success in this direction is the tool room which designs and produces all the firm's tools. Multiple tools from this department are assisting to a large extent in cheapening production.

The firm believes in training apprentices for the skilled posts, and when the apprenticeship course is finished, they are sent to the Swiss factory for about a year, so that the overall training is very thorough.

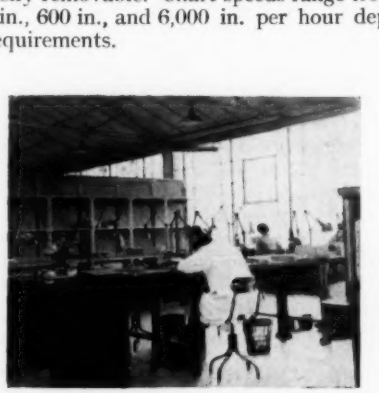
The firm has now 75 employees, and it is a pleasure to record that one third of each year's profits are set aside for distribution to the staff.

The range of products now includes, in addition to pressure gauge movements and drum type clock movements mentioned above, gears of all types, circular chart movements, strip chart movements, escapements, synchronous motors, etc.

Miniature instruments must be increasingly used if instrument panels are not to become excessively large. The very latest product of the firm, at the time of going to press, is a 4 in. strip chart movement. In this device, the drawing unit may be a spring driven hand-wound mechanical clock, a synchronous motor, a synchronous motor fitted with a mechanical movement to provide 10 hours' reserve, an electrical impulse clock or a pneumatic clock driven by pneumatic pulses. In addition, a pneumatic re-wind feature may be fitted to the mechanical clocks. The design enables any driving unit to be interchanged with others of a different type by simply removing a few screws. The chart holder member is fixed by a bayonet joint to the driving unit and is easily removable. Chart speeds range from 1 in., 5 in., 60 in., 600 in., and 6,000 in. per hour dependent on the requirements.



Entrance and part of factory front.



An assembly shop.

Nuclear Reactor Power Plant Simulator

AN Elliott Nuclear Reactor Power Plant Simulator Type ND481 has recently been ordered by the Central Electricity Generating Board for delivery in July, 1959. It will be installed initially at Berkeley Nuclear Power Station and is designed to assist in the training of reactor operators for current and future series of nuclear power stations.

Introduction

In nuclear power stations certain precautions must be observed, and the safety and interlock circuits severely restrict the operations which may be carried out. As a result it is difficult to give operators adequate experience of different operating and fault conditions in a reasonably short period of training on a real plant. Moreover, the use of the plant for training purposes is undesirable in view of its high capital cost, and the increased risk of unintended shut-downs or accidents.

These difficulties may be overcome by the use of a suitable simulator, which should preferably be as realistic as possible both in performance and the appearance of the control equipment and instruments presented to the trainee. On such a simulator, operations which would be extremely hazardous on a real plant may be carried out in safety. It can also be used in the investigation of plant performance and stability.

The Elliott Nuclear Power Plant Simulator is designed to enable the training of personnel in reactor power plant operation under realistic conditions, and it will reproduce on suitable instruments the responses of an actual nuclear power plant to the operation of appropriate controls. The present model is arranged to simulate a power plant having a graphite moderated, gas cooled, natural uranium fuelled reactor with multiple heat exchangers and using a dual pressure steam cycle.

Output signals corresponding to plant variables are produced by an electronic analogue computer, which is of unit construction and is so arranged that if required it may be adapted to simulate other types of reactor. Alternatively, additional computing units, indicators, etc., may be connected to the computer to enable the study of nuclear power plant control problems.

A control desk is provided for the operator, and this with two separate boiler panels carries all the instruments and controls required for the operation of the plant.

Construction

The simulator consists of three sections, a control desk, a computer cabinet and two wall mounting boiler panels (see Fig. 1).

It is based on an electronic analogue computer, and the quantities simulated are all represented by voltages in the range -100 to $+100$ V d.c. Accordingly, instruments on the desk and boiler panels take the form of appropriately scaled voltmeters and self-balancing potentiometers.

The control desk is of similar shape and size to an actual reactor control desk. It is in the form of a console with a central horizontal writing surface provided with a plastic veneer, flanked by two wings with sloping sub-panels on which control switches, etc., are fitted. Recorders, indicators and signal lamps are mounted on the faces of panels rising behind the writing surface and on both wings of the desk. The overall dimensions are approximately 4 ft 6 in. high, 12 ft wide and 4 ft deep front to back.

All the controls required for the operation of the plant and all the instruments except those referring to the steam and water side of the boilers are mounted on the desk. These include indicators and recorders showing control rod positions, reactor power level on linear and logarithmic scales, power deviation from a chosen value, doubling time, coolant flow and fuel element temperature, coolant inlet and outlet temperatures, moderator temperature and the generator loads. Amongst the controls are raise/lower switches con-

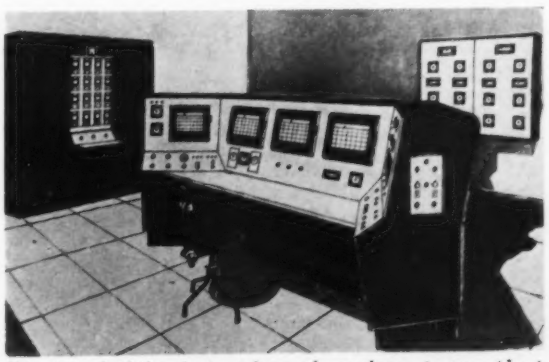


Fig. 1. Artist's impression of nuclear power plant simulator.

trolling reactor shut-off rods and control rods, blower speed, turbine steam valves, and boiler feedwater valves.

An emergency shut-down button, a reset trip button and a number of trip units operating on high flux, short doubling time, high fuel element temperature, etc., are also provided.

Certain controls are provided for the use of an instructor to enable the introduction of disturbances into the plant for training purposes. These can be used to vary the reactor excess k either gradually or in a sudden step, to effectively trip out one or both generators, to stop one blower, or to produce the effects of faults in the feedwater supply system. As they would not be available to an operator on a real plant, these controls are segregated on a small panel recessed into the end of the right-hand wing of the desk.

Only passive computing elements are mounted in the desk and the bulk of the computing elements including more than seventy drift corrected d.c. amplifiers and ten servo-multipliers, complete with power supply units and reference units, are contained in the computer cabinet which is approximately 7 ft high, 6 ft 6 in. wide and 2 ft deep. It is built in three sections, each provided with a cooling fan, and is so designed that it can be extended if required at a later date by the addition of further cabinets of the Elliott G-PAC (General Purpose Analogue Computer) type.

The servo-multipliers are grouped in the centre section of the computer, and the dials and pointers showing their shaft positions are visible to provide a check on the operation of the computer in case of need. The centre section also carries a panel of preset controls by which certain of the plant parameters can be changed when it is desired to change the model of power plant simulated. It is also provided with certain other controls concerned with the running of the simulator, and a meter to monitor its operation.

The total power consumption of the simulator is approximately 3·5 kW on a 230 V, 50 c/s, single phase supply.

The two boiler panels carry only instruments referring to the steam and water sides of the boilers. The instruments on one show the conditions in any one of the "good" boilers No. 1-5, while those on the other show the conditions in No. 6, the "failing" boiler.

The quantities shown on each are the respective H.P and L.P. steam pressures and temperatures, the boiler drum levels and the feedwater flows.

Cables interconnecting the computer, the desk and the boiler panels are preformed and laid in a single floor duct running between them.

Functions of the Simulator

The simulator represents a graphite moderated, gas cooled, natural uranium fuelled reactor. There are six blowers and six heat exchangers which supply two turbo-alternators working on a dual pressure cycle.

(a) Simulation of the Reactor

Complete circuits are provided to compute the reactor power output and temperatures taking into account shut-down rod and control rod positions, inherent excess k, six groups of delayed neutrons, heat transfer and temperature coefficient effects, and xenon poisoning.

The machine is provided with an automatic re-scaling system to make it possible to carry out start-up procedures covering more than seven decades from the full shut-down condition. It operates on ranges of from 40 W to 5 kW, from 5 kW to 5 MW and from 5 MW to 500 MW. About one second is taken for the re-scaling process when the end of each range is reached.

Provision has been made for a scaling factor of 1/100th to be introduced into the power term fed to the reactor temperature computing circuits while the computer is on its middle range. The temperature computing circuits can thus be brought into operation in the middle range, and warming up commences at 5 kW.

The reactor kinetics circuits are arranged so that a variable neutron source term may be introduced during start-up, and a suitable control is provided for the operator. Normally, the source is effective on the lowest range only, being attenuated 100 times when the computer changes over to the middle range and disconnected on the high range. It can, however, be used with effectively 100,000 times its normal value in starting up the reactor directly on the high range by operating a "Rapid Start-up" switch to reconnect it.

Alternatively, the simulator may be set on the high range and initial conditions of power, temperatures and delayed neutron populations set into the computing circuits.

(b) Simulation of the Boilers and Turbo-alternators

Circuits are provided to compute the heat transfer and temperatures in the H.P. and L.P. economisers, evaporators and superheaters of the boilers and the corresponding pressures, saturation temperatures and rates of evaporation. Further circuits determine the H.P. and L.P. drum water levels on the five "good" boilers and the sixth "failing" boiler.

Simulated steam dumping valves are provided to dispose of steam generated in excess of the amount which can be used in the turbines either because it exceeds their ratings or because the electrical load has been diconnected. In the real plant, this steam will either be condensed in a dump condenser or be blown off to atmosphere through safety valves, but for simulation purposes it is immaterial which occurs. As there is no direct indication of the dumping of steam, a pair of signal lamps are provided on the instructor's panel to give warning when it happens.

The turbo-alternators are simulated by circuits in which the steam flows are determined by the H.P. and L.P. steam valve openings and the boiler pressures. Generator loads are then estimated from the total heat delivered by the steam to each turbine multiplied by an efficiency factor. When either generator is tripped, the corresponding steam valve closes immediately and the load falls to zero. The boiler pressures will then rise and unless the other generator can absorb the extra steam or the reactor power is reduced, the dumping valves will open.

The effects of the various fault conditions which can be initiated by the instructor are produced by introducing appropriate changes in the computing circuits. Thus when the sixth blower is caused to fail or the

corresponding boiler is shut down, the simulated flow through the reactor is reduced to $\frac{5}{8}$ of its former value, the steam flows are correspondingly reduced, and the pressures and temperatures in the shut-down boiler slowly fall as it "cools off".

Under normal running conditions, the feedwater supplies to the boilers are controlled by a simulated automatic control system, but the instructor is provided with the means of causing the regulator valves on the H.P. and L.P. sections of boiler No. 6 to jam shut or fully open, or the failure of the H.P. or L.P. feedwater supplies to all the boilers. When such a fault occurs, the feedwater flow and drum level indicators show the appropriate changes and the operator is required to take action. This he can do by isolating the faulty sections of the plant and turning on manually controlled emergency supplies to replace the normal feeds.

Special Features of the Simulator

The principal features of the simulator are, first, that within its limitations of size and cost it produces an accurate simulation of the behaviour of the reactor and boilers under most transient conditions, and secondly, that it is flexible and easily adapted to simulate differing reactors. It is not restricted to certain programmes of operation and it can show the differing relations of simulated quantities under various conditions of dynamic operation.

Though analogous to the simulators employed in training aircrews, it differs from them in that it is electronic rather than electro-mechanically or electro-hydraulically operated and that it can be readily adapted to simulate any of a number of generally similar plants while the latter are generally designed to represent only one aircraft. Day-to-day changes in the plant parameters to modify the simulator to represent, say, any of the reactor power plants now being built can be made quickly by means of the preset potentiometers on the computer cabinet. Major changes to cause it to represent, say, a fast reactor or one with a different fuel or moderator can be made quite readily if less conveniently by changing component values in the computing circuits.

An article on "Analogue computers in the nuclear power programme", by J. C. Nutter, Chief Engineer, Nuclear Division, Elliott Brothers (London) Ltd., appeared in *Instrument Practice* in January, 1958.

X-ray Quantometer

A new production X-ray quantometer has been produced by Applied Research Laboratories Inc. The system includes a spectrometer with X-ray tube, power supply, and recording console.

The sample is bombarded with high intensity X-rays. The excited atoms in the sample then emit fluorescent X-ray radiation at characteristic wavelengths. Measurement of the intensity of this radiation by various detectors provides accurate quantitative analysis of each element in the sample. In the company's ratio recording system, the use of either an internal or external standard permits high accuracy in measurement. The PXQ significantly widens the wavelength range available for simultaneous analysis.

Each radial position can hold two monochromators. Fluorescent radiation from the sample is directed to two separately adjustable curved crystals through primary slits, which are staggered in double-decker fashion. The crystals diffract and focus the respective beams in opposite directions on to secondary slits in front of appropriate detectors.

All monochromators receive radiation from the same area of sample. Solids, liquids or powders may be tested with equal ease by use of various cartridges. The cartridge is easily inserted, and registers accurately on the primary chamber. An automatic safety shutter is actuated as the cartridge is snapped into place. A water jacket for temperature control of liquids can be fitted into the selected sample container.

Multiple monochromators are placed radially around the sample and X-ray tube. The basic instrument, accommodating up to 13 channels, is 54 in. high. It can be readily expanded to 23 channel capacity by the addition of a semicircular annex. Sheet steel cover plates ensure radiation protection.

The primary chamber, a radiation-safe brass casting, is rigidly suspended from three monochromator plates. It can be easily removed. External standard samples can be easily inserted and changed. Non-dispersive fluorescent radiation from the standard is funnelled to a detector which is supported on the slit mounting plate.

The slit cluster fits into the chamber as a unit, and consists of semi-fixed slits arranged radially and staggered in two planes. Also registered in the primary chamber is the Machlett OEG-60 end window X-ray tube which is saddle-mounted to the front bulkhead. A spectral purity side window X-ray tube such as the Machlett OEG-50S can be installed if desired. Such a tube entails the sacrifice of six channels in the dual PXQ unit, but none in the single unit.

With the development of the curved crystal, the PXQ optical system provides true focusing of X-rays with resolution approaching the optimum. There is minimum loss of intensity. Designed for the wavelength region of 0·35 Å through 10·2 Å, a choice of several crystals is available: LiF, quartz, NaCl, ADP and EDT. Various lattice spacings and curvatures may be installed to suit particular problems. Profiling to optimum crystal angle is safely accomplished from outside the instrument during operation by means of a helical gear drive.

Since air absorption interferes with the detection of soft X-rays, a helium atmosphere must be used for elements under atomic number 20. This inert gas is introduced by a special boot, and extends from the sample surface to the detector window.

Distance-Velocity Lag Simulator Type ND.111

The distance-velocity or transport lag simulator is an instrument designed for use in conjunction with analogue computing equipment for the representation of large transit time effects which occur in a number of industrial processes, usually associated with the flow of fluids in ducts. The transport time provided by the instrument can be varied between 2 and 60 seconds, and is inversely proportional to the magnitude of an electrical input signal, so that it may be either preselected to a constant value, or caused to vary in relation to other plant parameters represented in the computer. The input and output signals corresponding to the transported information may be in the range ± 100 V and between d.c. and the cut-off frequency which is dependent upon the transport time. Between these limits the output amplitude and phase are independent of the signal frequency content.

Operation

The instruments consist basically of a 100 position motor-driven switch having two wipers, one of which is connected to the output of a "writing" amplifier, and the other to the input of a "reading" amplifier. The motor, whose speed is servo controlled, drives the switch continuously in one direction, via a reduction drive, the time taken for one complete revolution being equal to the distance-velocity lag. To each of the 100 fixed contacts is connected a 22,000 pF polystyrene capacitor, which are successively charged to the "writing" amplifier output level as the switch rotates. The two wipers are close together on a rotating arm, the leading wiper "reading" the voltage to which the capacitors were charged by the "writing" wiper during the previous revolution, after which operation the capacitors are recharged by the trailing "writing" wiper to new levels which are stored for a further revolution time.

Since the process is essentially discontinuous, the output signal appears in a number of discrete voltage steps. This factor determines the maximum signal frequency transported when considered together with the range of transport times and accuracy required. There being 100 fixed contacts with a spacing between reading and writing wipers equivalent to $1\frac{1}{2}$ of these, the output signal comprises some 98 samples per transit time.

A small smoothing capacitor in the reading amplifier prevents the output falling to zero during the transport of the wiper from one contact to the next.

Both the writing and the reading amplifiers are of unity external gain, the d.c. input impedance being very high, and the output of the latter is capable of delivering up to 15 mA into a load. The range of voltage which the amplifiers will handle is from -100 V to $+100$ V.

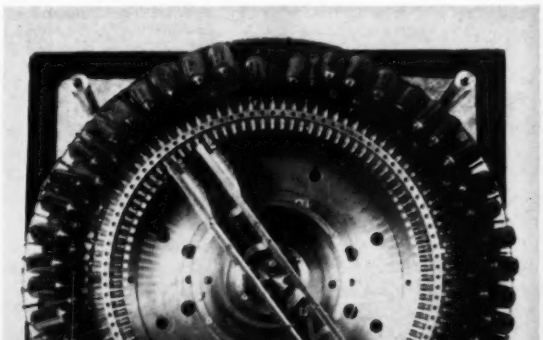
The servo drive system is so arranged that for applied input voltages from 3·3 V to 100 V the motor rotates at 100 to 3,000 r.p.m., a 100 : 1 step-down gear train providing the required speed at the switch shaft. The system is capable of rotating steadily at significantly lower speeds, giving larger transit delays, though linearity between shaft speed and input signal is no longer maintained.

Loss of charge on the capacitors during the longest delay is kept to less than 0·1% by maintaining the leakage insulation of the contact-capacitor combination in the region of 10^{13} ohms.

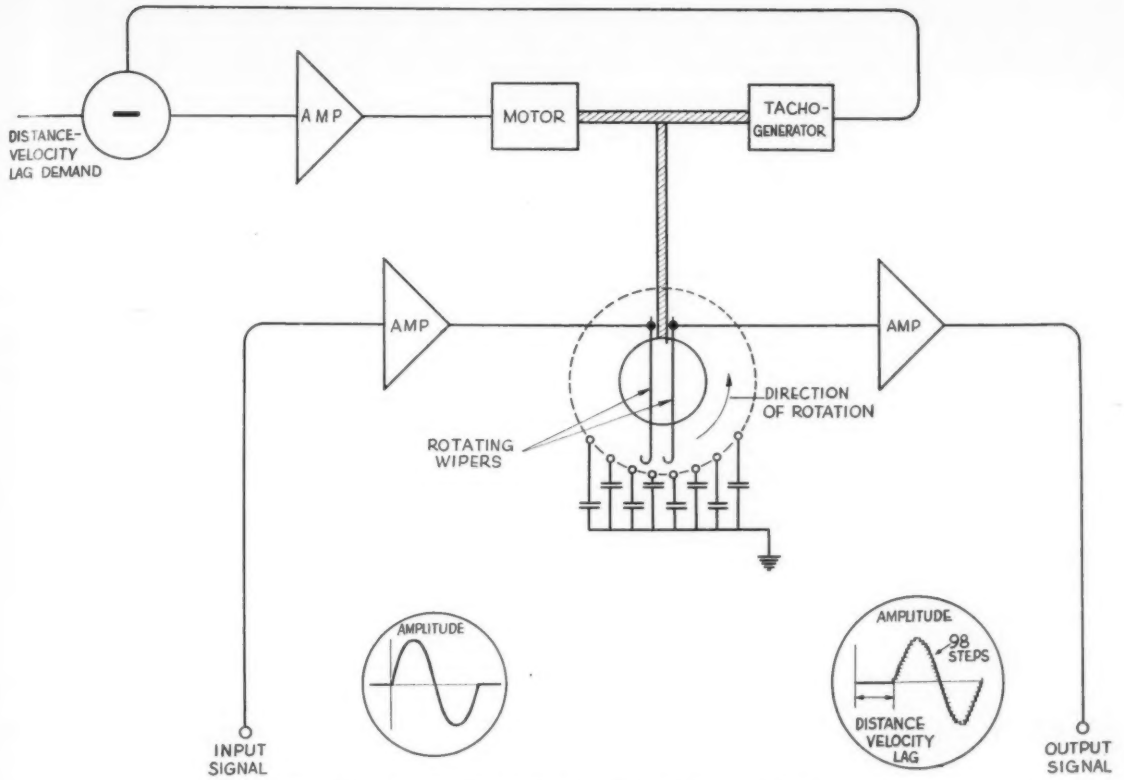
Specification

(a) Switch and motor unit

The fixed contacts are mounted in a dural ring, being insulated from this by means of ceramic bushes. The capacitors are connected between these contacts and an insulated ring. The wipers are mounted on two



Transit time unit.



Fundamental circuit of distance-velocity lag simulator.

parallel dural arms which are in turn carried on a rotating perspex disc, on the lower side of which are two silver slip-rings. Beneath this is a fixed disc, also of perspex, carrying the two pairs of brushes.

The existence of an air gap between each of the fixed contacts avoids leakage effects which might be caused by transfer of contact material over the surface of a solid insulator, thus making possible the use of contact materials with both good mechanical and suitable electrical properties. By careful control of manufacturing tolerances the plane of rotation of the wipers is maintained parallel with that of the contact ring to within very fine limits. Thus since contact pressure is effectively constant at each position, wear and contact bounce are more easily controlled, improving the reliability of the equipment.

The shaft drive is taken from the motor via a 100 : 1 gear reduction. The motor and tachogenerator spindles are in line, the drive to the latter being via two pairs of nylon gears, with a step-down ratio of 2·25 : 1.

(b) Amplifier

Since, in general, studies involving the simulation of distance-velocity lags necessitate the use of two units simultaneously in go and return circuits, the standard arrangement houses two complete sets of amplifiers on a single chassis. Apart from power supplies, which are not included, the amplifiers are electrically independent.

Dimensions

The amplifier chassis, for use in conjunction with two transport lag simulators, measures 19 in. × 15½ in. × 8¾ in., weighs approximately 5 lb, and may be mounted on a standard 19 in. rack.

The switch unit measures 16½ in. × 13¼ in. × 7¼ in., including the cover, and may be mounted on side runners in the same rack.

Connections are made via plugs and sockets at the rear of the amplifier chassis, and on the undersides of the switch unit baseplates. Inter-connecting leads are normally supplied to specified length.

Performance

The relation between transport time and servo input voltage within the range 2 to 60 seconds is linear to better than 1%, 100 V d.c. corresponding to 2 seconds and 3·3 V d.c. to 60 seconds.

The unit has a transfer ratio of unity, for signals in the range ±100 V d.c., errors contributed from all sources being less than 1% over the working range of transfer times. The reading accuracy of a.c. input signals, due to the fact that the output appears in discrete steps, is calculable from signal frequency and transport delay on the basis that there are approximately 98 samples read out per transport time. In most practical applications this error is small enough to be ignored.

HEATING AND VENTILATING EQUIPMENT IN THE ROLLS-ROYCE AERO ENGINE ALTITUDE TEST PLANT—SINFIN "C"

The new Rolls-Royce plant consists of two test chambers each containing one high altitude test cell in which the gas turbine engines for test are run. While under test there are no personnel in the cell, instrument readings and general control being exercised from a central control room. On completion of an engine test the cell is opened and large volumes of air are exhausted to clear away a possible accumulation of noxious gases. Ventilation and quick re-heating of the cells for the engineers working on the dismantling and erection of the engines is a necessity, if maximum utilisation of the cells is to be ensured. To achieve this end, the Norris Company has installed a plenum plant. This consists of a centrifugal fan drawing fresh air through a hair type filter and steam heater battery before delivering the warm air to the working areas through multi-louvre adjustable grilles. As it was envisaged that work could be proceeding in both test chambers at one time or that either might be used individually, the fan is driven by means of a two-speed motor to operate on low speed when only one area is in use, or on high speed if both are in use. Isolating dampers were fitted in the branch ducts serving each area, so that the one not in use need not be unnecessarily heated.

The air heater battery is under thermostatic control, a valve on the steam main being controlled by a thermostat in the working space, the control being of the fully modulating type. Again, thermostatic control was designed to obtain control from either of the two test chambers, or with both in use, and a selector switch was provided to enable the appropriate control scheme to be brought into operation. The thermostatic control system is of the electronic type, the essential feature of thermostats in the working space being that they should be of a flameproof nature to avoid explosion risks.

In addition to the foregoing, Norris Warming Company Ltd. also installed the heating and ventilating system in the Exhauster Station and Input Circuit Buildings at the same site.

Services and Facilities of the Electronic Calibration Centre

The primary mission of the National Bureau of Standards' new Electronic Calibration Centre is to calibrate inter-laboratory standards for such quantities as voltage, power, and impedance in terms of the national standards maintained by N.B.S. These inter-laboratory standards, in turn, are used to assure the accuracy of reference and working standards in laboratories, on the production line, and in overhaul stations throughout the United States.

The quantity of electronic calibrations required today in the design, manufacture, and adjustment of extremely complex electronic weapons, communications equipment, and industrial electronic apparatus is so great that it is necessary to extend the national standards to the shop or field instruments used for this work. The large number of links, through which the units of measurement must be transferred, requires the highest practicable accuracy at each step in order to assure adequate accuracy of the shop and field instruments. The Electronic Calibration Centre is being equipped to meet these accuracy requirements while handling the increasing calibration workload.

The fundamental system of electrical measurement now employed in the United States uses absolute units, that is, units derived from the fundamental units of length, mass, and time: the metre, kilogram, and second. Basic to the absolute system of electrical units are the absolute ohm and the absolute ampere. The absolute ohm is derived from the absolute henry, based on an inductor of accurately known dimensions. The absolute ampere is established in terms of the magnetic force on an accurately dimensioned current-carrying coil, measured with a current balance. These basic standards are maintained in the Bureau's laboratories in Washington, D.C.

Other units, such as the watt and the kilowatt hour, are obtained by combining these units and by extending the scale of measurement. The units then are transferred to higher frequencies by appropriate techniques.

Services offered by the calibration centre cover three broad frequency ranges: low frequency (zero frequency to about 30 kc); high frequency (30 kc to about 300 Mc); and microwave (above 300 Mc).

Somewhat more than half of the initial instrumentation programme has been completed, and the Centre now is able to provide the most urgently needed services. Additional standards and instrumentation, beyond the present programme, will be required in the future to replace those made obsolete by technological advances and to extend the capabilities of the Centre as new calibration requirements arise. The eventual goal is to measure and standardise in the Centre all electronic quantities for which there is a substantial calibration need. Calibrations required only infrequently may often be obtained elsewhere in the Bureau.

Resistance Standards

The Bureau maintains the unit of resistance at its Washington laboratories by means of a group of ten extremely accurate, sealed double-wall 1 ohm standard resistors. Resistors of this type, compared frequently

with the primary reference group, also form the basis of measurements made in the Electronic Calibration Centre. It is expected that some of these resistors will become a part of the primary group. The resistance calibration services provided by the Centre are limited to high or moderately high-precision apparatus.

A Wenner bridge is used for calibrating standard resistors. This bridge incorporates a thermostatically-regulated oil bath for maintaining the bridge and the resistors under test at a constant known temperature. It employs a direct-reading ratio set to compare resistors with known standards by either a Kelvin double bridge or a Wheatstone bridge. Resistance comparisons, using the Wenner bridge, can be made to one part in ten million under optimum conditions.

The components of bridges and resistance boxes are calibrated with known standard resistors by use of a direct-reading ratio set. Potentiometers are calibrated with a universal ratio set. With this device the ratio of the potentiometer e.m.f.-dial resistance to the standard-cell-dial resistance is determined for all settings of the e.m.f. and standard-cell dials.

Inductance Standards

Stable standards of self-inductance are used as components of a.c. bridges and other circuits employed in impedance measurements. Such inductors ordinarily are used at fixed frequencies, usually 100, 400, or 1,000 c/s. Because inductance standards are employed in bridge circuits where the current in the inductor is not accurately known, it is of greatest importance that the current coefficient of inductance be practically zero. This probably precludes the use of inductors having metal or metal powder cores as standards.

An "equal substitution" method using a Maxwell-Wien bridge is now employed in the Centre. Three groups of calibrated inductors serve as standards. They can be intercompared frequently to detect relative drifts or changes. One group is calibrated periodically against the national standards of capacitance and resistance. It is anticipated that a precision Maxwell-Wien bridge will be constructed at the Centre to measure a wider range of inductances and to double-check the stability of the standards.

Capacitance Standards

Fixed capacitors, with air dielectric for low values of capacitance and mica dielectric for higher values, are used as components of a.c. bridges as standards for the external calibration of bridges, and for the calibration of other standards by substitution techniques. Three-terminal capacitors are useful in certain types of bridges and in other measurement circuits where the direct capacitance is of importance. More often, three-terminal capacitors are used simply as two-terminal capacitors, with the case connected to one of the capacitance terminals. The centre is equipped to calibrate either type and can occasionally provide approximate conductance values where needed.

Equipment employed in the centre for calibrating capacitors consists of a capacitance bridge having internal capacitance standards which are, in turn, calibrated by step-up procedures using standard capacitors. Three groups of standard capacitors are available for intercomparison to detect relative drifts or changes. One group is calibrated periodically in terms of the national standard of capacitance.

Standard Cells

Weston type cadmium standard cells are of two general classes: (1) saturated cells, used principally for reference standards of electromotive force; and (2) unsaturated cells, used chiefly as working standards of electromotive force.

The Centre is prepared to calibrate both types. With a microvolt potentiometer, they are compared directly to the saturated standard cells. These cells are compared periodically with the group of saturated cells which the Bureau uses to maintain the unit of electromotive force.

Because saturated cells have a temperature coefficient of about 50 μV/°C, the temperature at which they are calibrated must be very closely regulated. At present, facilities in the Centre include temperature-controlled air baths which are constant within a few hundredths of a degree centigrade. Consequently, the e.m.f. of standard cells can be measured with a precision of about 2 μV and can be certified to an accuracy of 0·001%. After installation of a temperature-controlled oil bath, even greater accuracy will be obtained. This installation should be completed at the end of 1958.

Unsaturated standard cells have rather low temperature coefficients of approximately 5 μV/°C. Consequently, temperature control is not nearly as important as for saturated cells. Results of calibration of unsaturated cells normally are given to 10 μV, and the cells are certified to 0·01%.

Electrical Instruments

Indicating instruments are essential to the measurement of electrical quantities. Sometimes they are employed as reference instruments exclusively for calibrating other instruments. More often they are used as direct-reading working instruments. The Centre is prepared to calibrate those used as reference instruments in the 0·5% accuracy class or better.

Transformers

The Centre is equipped for calibration at 60 c/s of current transformers having 5 amp secondary windings and primary current ranges of 0·1 to 4,000 amp, and voltage transformers having 110 to 120 V secondary windings and primary-to-secondary voltage ratios of 1 to 120. At some future time, the Centre expects to do most of these calibrations also at a frequency of 400 c/s.

Other Standards

Other standards which can be calibrated include standard resistors for current measurements and volt boxes. Certain other ratio devices can be calibrated as the occasion arises.

No provisions have been made for calibrating watt-hour meters. At the present time, these are calibrated only at the Washington laboratories. Facilities for these and for other types of standards in the fields of electrical current, voltage, power, and energy may be added if the demand is great enough.

A Computer in the Service of the Steel Industry

Introduction

THE new building recently opened by Stewarts and Lloyds Ltd. at Corby, Northants, accommodates the Central Office and the Corby branch of the Department of Research and Technical Development. This department deals with general investigational and research work associated with the company and with fundamental research on high temperature steels and the manufacture of special steels. The administrative offices house the LEO computer which was installed and started operation in May, 1958.

Stewarts and Lloyds Ltd. first became interested in electronic digital computers in 1955, and a preliminary study was made of the payroll and related statistics at Corby. Some technical (as distinct from commercial) calculation was being done within the company, but it did not seem likely that the demand would be large enough to warrant a mathematical machine designed to do this kind of work alone, as was the case with the aircraft industry. Once the survey had begun, it became obvious that experience in planning and organising repetitive clerical work on a computer so that it could take nearly all the exceptional as well as the normal cases in its stride was of paramount importance. It also seemed probable that this experience could only be got by actually doing jobs on a reasonably typical machine. A very detailed "Job requirements statement" was produced and sent to several computer manufacturers. On the basis of their estimation of the feasibility of performing the task and the time and cost involved it was decided that a LEO computer would be the most suitable.

By the end of 1956 LEO computers had finished programming, but the solution of some technical problems had not been finally solved on LEO II and the demonstration followed by the service run could not begin until mid 1957. The delay, however, enabled the company to concentrate on the necessary retraining of the timekeepers and wages department staff.

The demonstration took the form of a parallel run on 520 men of the blast furnaces. The LEO payslips were scrutinised and compared with the conventional payroll. Discrepancies were investigated, diagnosed and corrected week by week so that the computer payroll was in agreement with the official one. This went on for five weeks, when parallel running was stopped, and a further 750 men brought in. In November, 1957, a further 500 were taken on with only one week in parallel. The total stayed at about 1,800 while work was being done on a service basis. This ceased in May, 1958, when the company's LEO II took over.

Because of the careful preparatory work LEO was in productive operation within three weeks of the packing cases arriving at Corby.

In general a commercial computer can be used in two ways:

(a) to do work which was already being done in more conventional ways;
(b) to do work which could not have been attempted by ordinary means.

The payroll which inaugurated the installation was planned to be extended to cover all manual employees at Corby. Within this first class of work, comprehensive invoicing and stock control are in preparation and plans are being made for LEO to control the extensive stores in the Corby area. It is not intended, however, that this important new tool shall remain a mere processor of essential but limited routines. Already active steps are being taken to associate LEO more and more with the company's productive operations.

Corby Payroll and Associated Routines on LEO

Payroll was chosen as the first application for LEO because it is a good test of a computer's capacity and reliability. The pay structure of a manual employee may be made up of half-a-dozen different elements: time pay, cost-of-living bonus, cost-of-living conversion rate, piecework pay, allowances and one or more production bonuses. Many men work on several different jobs each with different pay and bonus conditions in the course of the week, and special conditions apply to overtime.

There are three compulsory deductions from gross pay: income tax, national insurance and holiday fund, and sixteen kinds of voluntary deduction, e.g., rent, national savings, and voluntary pension fund contributions.

To reduce the handling of coin in the wages department when a man's net pay has been calculated it is rounded off to the nearest ten shillings above. In the following week, this overpayment is deducted and the remainder rounded off again.

In addition to the regular weekly tasks of the payroll and the compilation of labour statistics showing hours and earnings for each department by occupation and age group, returns for each employee are required by the Inland Revenue at the end of the tax year. Also whenever an employee goes on holiday it is necessary to calculate his holiday pay. This is governed by his earnings and hours worked in the previous fiscal year. Separate programmes are used to amend any item of the permanent or brought-forward information held for each employee and to aggregate charges to cost accounts and to print financial accounts and labour statistics.

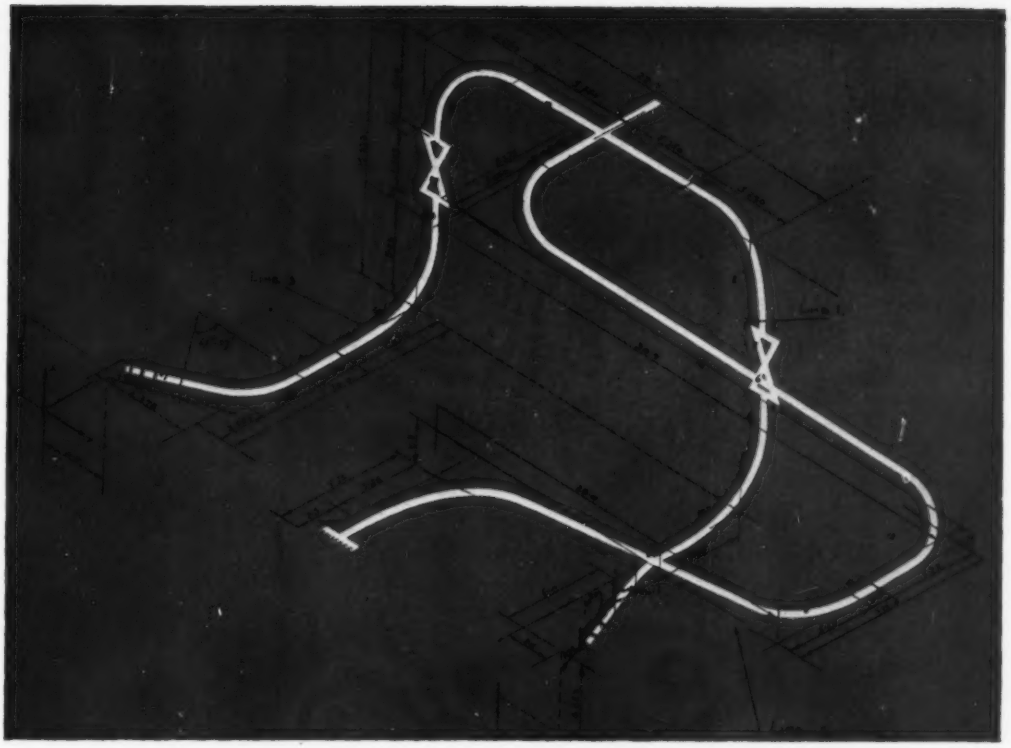


Diagram of two-anchor pipework layout illustrating factors which have to be taken into consideration in the calculation of stresses.

Pipework Stress Calculations on LEO

When the design of a pipework layout for conventional or atomic power stations or industrial plants is being undertaken, it is necessary to take into account the stresses produced by expansion of pipes working at temperatures above that of the surrounding air.

The amount of expansion may be small as in the case of hot water heating systems where the temperature is below that of boiling water. For such systems, no special provisions for absorbing expansion are required. For power plant and some process work, temperatures of up to 1,100°F are encountered with much greater amounts of expansion (about 0·1 in. on every foot of pipe at 1,100°F). Also at such high temperatures the strength of the steel is considerably reduced and the stress which can be permitted is correspondingly lower.

Because the ends of a run of pipework are fixed, the expansion of the pipe creates bending stresses in the pipe and loads on apparatus to which the pipe connects. The determination of these loads and stresses is an important part of the design. Several methods of carrying out these calculations have been developed and all have one common feature, that is that a large amount of arithmetic is involved. It is this arithmetical work which is now being carried out by LEO. Furthermore, the calculations for certain types of layout, which could in practice only be done by hand by using rather drastic simplifications, can now be done on LEO in proper form. The output from LEO gives the designer all the information he needs to determine whether the layout is satisfactory or not, as well as the deflections of the pipework required when the supports are designed. A drawing of the pipe layout for the test-run on LEO for this job is reproduced.

Works Pension Fund Statistics on LEO

In the administration of the works pension fund which came into operation in mid 1956, one of the first requirements was the costing by the actuaries of the non-contributory pension for both current and past service and of the concession made to voluntary contributors aged 55 and over, towards their additional pension, the total cost being spread proportionally over the various companies. An analysis of voluntary contribution was also required.

Later on information was needed to enable an annual investigation to be made by the actuaries into the effect on the fund of members leaving service and the entry of new members, with a view to adjusting future contributions, and to enable a complete evaluation of the fund to be carried out every five years. With such a vast amount of detail to be analysed, the need for some automatic method was obvious. LEO showed itself as the most suitable available medium for the job. The saving in time would be appreciable and once the programme was arranged, information could be run off year by year on the same scale.

Punched cards, one for each member, were used as input to the computer. On each card were punched the member's personal number, year of birth, date of joining the company, and paying point code and, in the case of a voluntary contributor, the weekly rate and date commenced, together with a concession indicator. A column was also used to distinguish members who had left the company for any reason. From this LEO produced all the statistics required.

The results completed on LEO to date are printed directly from the computer in duplicate on sheets 15 in. × 11 in. A code is printed on each sheet to denote the period, type and breakdown of the run, and the tables are ready for immediate use by the actuaries without modification or rearrangement.

The company proposes to make further use of LEO by extending the programme to cover the pension payments aspect once this has reached appreciable proportions.

The LEO II Computer

Principal Purpose	Commercial data processing and statistical work.
Word Length	Short —18 bits +sign (40 microseconds). Long —38 bits +sign (80 microseconds).
Type of Instruction	Single address, 19 bits, 32 basic actions of which 16 are modifiable including divide, square root, scale, collate, augment and special data sum check actions.
Arithmetic Unit	14 registers (including 3 modification registers).
Immediate Access Registers	Capacity 14 long words (39 bits). Type Mercury delay line. Access Zero effective access.
Main Quick Access Store	Type Mercury delay line. Capacity 2,048 short words (19 bits each). These may be taken in pairs to form words of 39 bits. Access 0·16 m.sec. average.
Buffer Store	Type Mercury delay line. Capacity Up to 288 of 19 bits. Access As above.
Auxiliary Store	Type Drums of 16,384 words each. Capacity Up to a total of 65,536 words of 19 bits. Access 1 rev. = 18·3 m.sec. but 2 buffers provided.
Mode of Operation	Serial fixed point.
Times for Arithmetical Operations (including all access time)	Addition: 0·34 milliseconds from immediate access register. 0·66 milliseconds from main store. Multiply: 0·66 to 3·5 milliseconds from main store. Divide: 3·5 milliseconds from main store.
Input (up to 4 operating simultaneously)	Paper tape 200 rows/sec. Punched cards (either punched in binary or any 2 hole alpha code) 200 cards/min. Magnetic tape (see below).
Output (up to 3 operating simultaneously)	Punched cards (either punched in binary or any 2 hole alpha code) Hollerith 100 cards/min. Lineprinter, 140 printing positions, 50 different characters, 4 plugboard layouts. Hollerith 100 lines/min. Powers 300 lines/min.
Magnetic Tape	Up to 8 decks—peak rate 10,000 digits per second—sustained simultaneous reading and writing including check at separate head, 4,000 digits per second.
Auxiliary Printing	Punch card operated typewriter—10 characters/sec.
Checking Facilities	Magnetic tape is completely re-read at a separate head after writing, and compared with contents of buffer. Punched cards are checked at a separate read station after output. Special orders are provided to make programmed input checks fast and easy. All information in drum store is parity checked.
Facilities	Provision is made for automatic conversion and reconversion between binary, decimal and sterling notations, arranging in addition for suppression of all non-significant zeroes, the insertion of signs and printing or punching of numbers in true decimal form. Optimum programming techniques are not required because the access to the store is so rapid. A special assembly programme is provided to enable programmes to be written in a simple form and all address and cross-references are computed automatically. Buffer stores are provided in each of the 4 input and 3 output channels and also between the auxiliary and main stores, thus enabling all to work in parallel with the computer: thus reading, punching, calculating, printing reference to the auxiliary store and the operation of any 2 of the 8 magnetic tape decks can all be carried out simultaneously. Input and output channels are each provided with switching facilities to enable immediate changes to be made in the ancillary equipment linked to the computer.

Basic cost of Computer £80,000—£100,000, according to number and type of input/output channels required.

Typical cost of complete system £100,000—£170,000, according to ancillary equipment included in installation.

AERODYNAMIC BEHAVIOUR OF GASES

A promising laboratory technique for solving the problem of obtaining data on the aerodynamic behaviour of gases at low densities has recently been developed by L. L. Marton, D. C. Schubert, and S. R. Mielczarek, of the U.S. National Bureau of Standards, in a research programme supported by the U.S. Office of Naval Research. The method uses an electron-optical Schlieren technique to produce a photographic image of the gas stream. Since it depends on the scattering of electrons in collisions with individual gas molecules, this technique is more effective at much lower pressures. It is, however, necessary that the gas density in the region of interest be higher than that in the remainder of the apparatus, and this can be assured by modern vacuum technique.

The apparatus already constructed extends the range of pressures at which gas flow may be studied down to less than 10^{-5} mm Hg. So far, the apparatus has been used to study the distribution of particle density in beams of cadmium atoms. After other vapours are studied in the same way, attention will be given to beams of the permanent gases.

A modification of this equipment has been designed which will permit measurement of the velocity distribution in beam particles that have been reflected from a metallic obstacle. The modification uses a stroboscopic principle and is now in the early testing stage. The data it provides will be used to compute the coefficients of thermal accommodation and viscous slip that are of interest in the aerodynamics of artificial earth satellites and guided missiles.

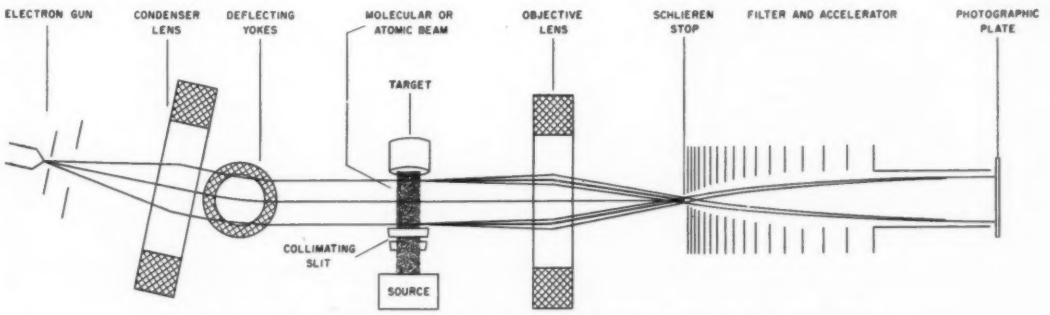
Basic to the Bureau's method is an electron-optical analogue of the Schlieren light-optical technique. The latter is used, for example, in obtaining the familiar photographs of shock waves produced by projectiles. In the electron-optical version, a wide beam of electrons diverging from a point source is directed through the region of gas flow and then focused on a small metal stop. If the gas stream were absent (and no other molecules were present), all of the electrons would be collected by the stop. However, electrons scattered by the gas molecules miss the stop and are recorded on a photographic plate located in the image plane conjugate to the mid-plane of the streaming gas. The advantage of the Schlieren technique is that it separates the scattered electrons from the non-scattered ones, and so prevents the latter from clouding the photographic image.

Electrons scattered from a given point in the gas stream are brought to a common focus on the photographic plate by means of a magnetic lens. The focus is sharpest for points in the mid-plane of the stream and does not depart too much from the optimum if the stream width is kept within reasonable limits. Under such circumstances the density of electrons impinging at any point on the plate is approximately proportional to the average gas density (or to the line integral of the gas density) along the electron trajectory.

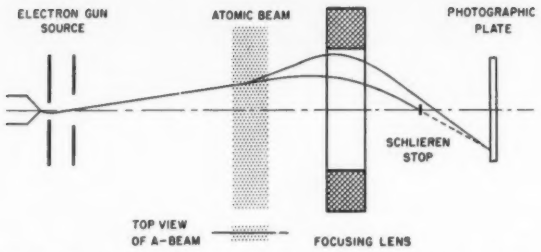
The problem of designing the optics of this type of instrument to provide simultaneously high sensitivity, sharp focus, and freedom from image distortion shares a number of features with the corresponding problems in electron microscopy and cathode ray tube development.

In the simple instrument described above, the energy of the exploring electrons is generally from 1 to 2 keV. This provides a convenient range of scattering angles, but it also produces an extremely weak photographic image. This problem is met by accelerating the electrons to about 15 keV after they have passed the Schlieren stop. It is found that such "post-acceleration" does provide the desired image intensity, but it also causes several additional difficulties that have had to be overcome.

One is that secondary electrons generated at the Schlieren stop are attracted to the photographic plate by the electrostatic post-acceleration field and provide an extraneous background. This was eliminated by



Instrument developed by N.B.S. for studying gas flow at low pressures.



Principle of electron optical Schlieren photography.

inserting a decelerating field between the post-acceleration field and the Schlieren stop. The new field can be made strong enough to repel all of the secondary electrons while being easily penetrable by electrons scattered from the main beam.

Now the electrostatic fields thus added to the basic Schlieren arrangement constitute a lens which must be taken into account if a sharp image is to be obtained. Electrostatic lenses usually suffer from a great amount of spherical aberration, which results in serious image distortion under the conditions of the present experiment. This was minimised by reducing the focusing action of the added deceleration and acceleration fields to a minimum, since the effect of the spherical aberration is correspondingly decreased. It was then possible, by careful design, to cancel the remaining "pin cushion" distortion with distortion of the opposite sign produced by the main focusing coil.

The gas stream is generated by the molecular-beam technique. Cadmium metal is evaporated in an oven fitted with a narrow rectangular slit through which the molecules can escape, and the rate of escape is kept sufficiently low so that the molecules travel in unobstructed straight-line paths. A collimating slit several centimetres away from the oven then defines a ribbon-shaped beam of molecules essentially free of lateral motion. The axis of the electron beam is directed parallel to the plane of the ribbon and perpendicular to the direction of advance of the molecules. Finally, after passing through the electron beam, the cadmium molecules are condensed on a surface at liquid-nitrogen temperature (77°K).

A second instrument is now being designed to apply a proposed technique for stroboscopic operation. The cadmium beam is cut into short pulses by means of a radially-slotted circular disc rotating at 8,000 r.p.m. The electron beam is also pulsed; it is cut off at all times except for an interval of a few tenths of a microsecond starting about 10 microseconds after the arrival of each pulse at a metal target. In this way a stroboscopic picture of the gas density is produced. Because the distance of any molecule from the target is equal to the product of the molecule's velocity and the chosen time interval (about 10 microseconds) since it struck the target, the picture also exhibits the distribution in velocity of the reflected molecules.

The instruments developed at the U.S. National Bureau of Standards for studying gas streams at very low pressures have evolved from the relatively simple electron analogue of the optical Schlieren arrangement. The basic electron Schlieren instrument itself was developed in several years of research in which the Schlieren technique was applied to the mapping of small electrostatic and magnetic fields inaccessible to other kinds of measurement.

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Computer Controls Cement Manufacture

Riverside Cement Company, a division of American Cement Corporation, has purchased an RW-300 digital control computer system as the first step toward fully automatic control of a cement manufacturing plant.

The electronic computer, manufactured by Thompson Ramo Wooldridge Inc., will guide the operation of a completely mechanised rock blending facility now being installed at Riverside's Oro Grande (Calif.) plant, and will also provide information to guide quarrying operations.

In addition to its control functions, the computer will collect and analyse data needed in planning automatic control systems for the entire cement manufacturing process. The long range objective is to utilise automation techniques wherever they will make possible higher product quality or lower cost.

The decision to purchase a computer followed a six-month application study. At first, the RW-300 system at Oro Grande will indicate required quarrying and stockpiling actions. The computer will keep track of the amount, chemical composition, and point of origin of thousands of tons of rock and other raw material loaded into Riverside's new blending facility. It will periodically calculate how much of what kinds of materials should be added to the pile to obtain the proper proportion of cement-making ingredients. The computation will indicate the most economical action to take on the basis of such factors as hauling distances and cost of quarrying in various areas.

Analysis of rock samples will continue to be accomplished with an X-ray spectrometer at the Oro Grande plant. The computer will automatically bring in data from the spectrometer and will perform all necessary calculations. Riverside has pioneered in the use of the X-ray spectrometer in the cement industry.

In addition to making control computations, the computer will log data from the plant's rotary kilns. It will provide accurate and continuous records of such variables as temperature, fuel gas, gas flow, and rotation speed. Built-in analogue-digital conversion equipment permits the computer to be connected directly to measuring instruments and control devices. This new transistorised computer is intended for on-line applications requiring dependable operation twenty-four hours a day.

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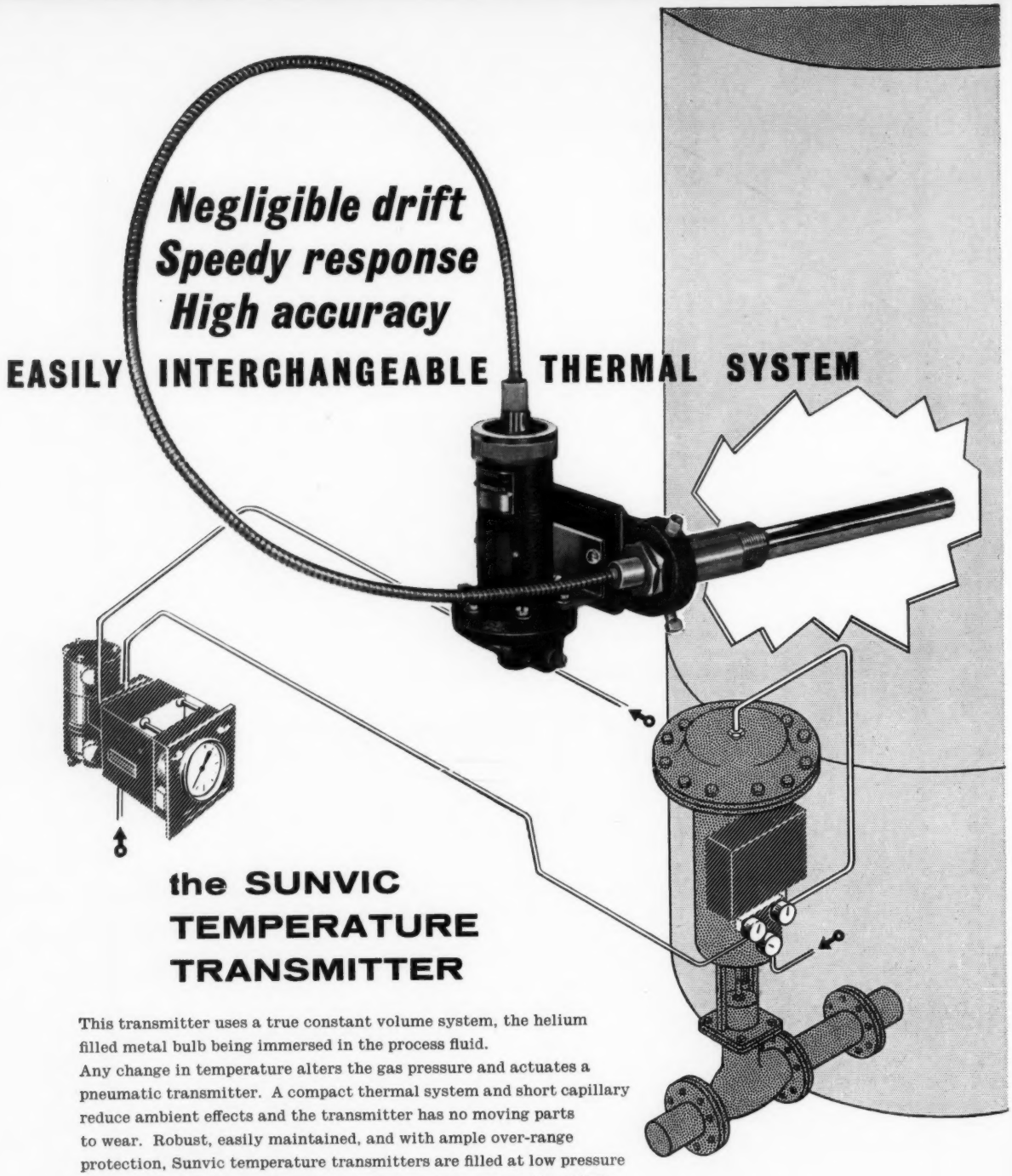

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THIS device may be used for operations necessitating the careful raising or lowering of equipment such as water baths, oil baths, heating mantles, etc., supporting Dewar flasks containing refrigerants when used for cooling traps in vacuum systems, and supporting flasks, etc., which must be readily removable, for instance in assemblies of interchangeable ground joint glassware.

The 8 in. square top and bottom plates are removable and from a minimum height of 3¼ in. the Labjack will extend to 11¼ in., giving a maximum lift of 8 in. It will lift up to 20 lb from zero height, but when slightly extended will lift 56 lb.

It is constructed of anodised light alloy and provided with a large bakelite operating knob.

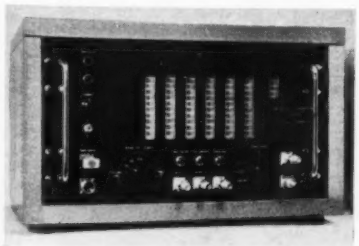
Full details may be obtained from J. W. Towers & Co. Ltd., Widnes, Lancs.

Frequency and Time Counters

THE complete range of Rochar frequency and time counters is now being marketed by Metrix Instruments Limited.

Model A478 covers the frequency range 10 c/s to 1·2 Mc/s with an accuracy of 1 in 105. All time interval measurements from 1 μ sec. upwards can also be made. A thermostatically controlled 100 kc/s crystal oscillator is employed as the basic time-base circuit in conjunction with decade multipliers and dividers. Facilities are provided for the connection to an external oscillator of even higher stability if required.

The count capacity is 999,999 (a further significant figure is available on an alternative model), and the digits are recorded on an illuminated display designed for easy reading at a distance.



Frequency and time counter.

The input range is 20 mV—50 V r.m.s. and the input impedance is 1 MΩ—40 pF. The instrument is of robust unit construction using standard sub-assemblies for easy maintenance or replacements.

Other models in the range cover frequencies from 2 c/s to 220 Mc/s.

Full details may be obtained from Metrix Instruments Ltd., 54 Victoria Road, Surbiton, Surrey.

Transistorised Level Control

THE new capacitance operated level control and indication equipment introduced by Lancashire Dynamo Electronic Products Limited, of Rugeley, Staffs., will be known as the T.L.C. 1 (single level) and T.L.C. 2 (multi level).

In the new equipment transistor oscillators are used to replace oscillator valves in the detector circuit which registers the change in capacitance at a probe or similar electrode on the approach or recession of a material. In the transistor oscillator circuit, the external capacitance represented by probe and earth is connected to the tuned circuit of the oscillator. With the high level probe unit, oscillation occurs when the probe is clear of the material and under these conditions the relay in the control unit is energised. When the material reaches the level of the probe, the change in capacitance causes the oscillation to be reduced and finally cease. The reduced amplitude of oscillation is detected by a further transistor circuit which in turn releases the control relay.

With the low level probe head unit, the system operates in reverse, the relay in the control unit being energised when the probe is completely immersed.

In both high and low level control, the circuit is so arranged that failure of equipment or supply will cause the installation to fail to safe.

This use of transistors has resulted in several important improvements in design and performance. The entire level detector circuit is housed within the probe head casting. The remote control unit can be mounted any distance away from the probe head unit, with only three interconnecting wires. All wiring external to the remote control unit is at a maximum potential of 12 volts d.c. to earth. The maximum current which can be drawn in the connecting cables under short circuit conditions is 50 milliamperes d.c.

The common probe head unit accepts any of a number of probes designed to cover a maximum variety of industrial applications. Maximum probe current is 1 milliamp at 6 volts R.M.S. at a high frequency.

The probes are:—

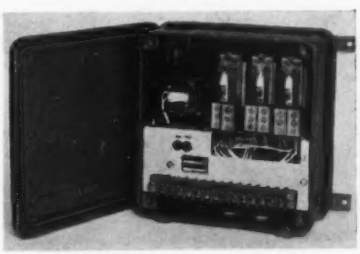
(1) *Normal duty probe*—for small granulated solids and chemically inert liquids (12 in. long, ⅜ in. dia., stainless steel).
(2) *Heavy duty probe*—for heavy materials where probe may be subjected to considerable impact (6 in. long, 2½ in. dia. stainless steel).
(3) *Angled probe*—for powders where "build-up" would occur on a normal duty horizontal probe, the angled probe has an insulated glazed ceramic sheath.
(4) *Suspension probe*—for vertical suspension above container.

with two special mounting assemblies:—

(a) *Remote mounting probe*—where lack of space or high material temperature makes standard arrangement impossible.
(b) *Mounting flange*—where flange mounting is preferred to standard 1 in. B.S.P. tapped hole.

The unit in sensitive form is capable of operating for changes of capacitance of ±2 pF. Excellent long term stability, and stability against supply voltage changes, has been proved. Operation is satisfactory at ambient temperatures up to 50°C. The equipment is substantially independent of normal mains supply fluctuations, variations in the differential operating capacitance being not more than ±0·8 μF for mains voltage fluctuation of ±15% from the nominal

Feed or alarm circuits include one pair of normally open and one pair of normally



T.L.C.2 multi-level controller.

closed contacts, isolated from each other and from internal power supplies, and rated for non-inductive watts at 5 amperes 230 volts or 1 ampere 440 volts 50/60 c/s a.c. Operation is on 200/250 volts or 110 volts 50/60 c/s single phase supplies, and the unit imposes a load of 30 V.A. approximately.

The mechanical construction is rugged, making use of a cast light alloy case, and the control unit measures only 7⅝ in. × 7⅝ in. × 4 in. with a choice of either back or base mounting. All units are fully weather proofed with synthetic rubber gaskets between metal surfaces for sealing.

Full details may be obtained from Lancashire Dynamo Electronic Products Ltd., Rugeley, Staffs.

Melting Point Apparatus

Boost heating gives temperature increases up to 200°C in 4·5 min, 300°C in 9 min, and special attention to cooling gives a return to normal in a time almost equally impressive. There is also provision for fine control of the temperature as melting points are reached.

The melting point tubes are viewed through a large lens so tilted that the operator may keep tubes and thermometer all simultaneously under observation. The tubes are illuminated obliquely, without shadow or glare, and the background may be changed from light to dark or *vice versa* at a touch. The heating block takes three tubes, so that the method of mixed melting points may be used. The apparatus is housed in a case, base 9 in. × 6 in., standing on rubber feet, with mains and boost switches and knob temperature control all brought to handy front positions.

Full details may be obtained from A. Gallenkamp & Co. Ltd., Sun Street, London, E.C.2.

Melting point apparatus.

A New Tube with Helical P.D.A.

A new high-brightness, high-sensitivity instrument cathode ray tube employing helical post-deflection acceleration has been announced by Mullard Limited. The characteristics of this new tube (type DH10-78) suit it for a large variety of applications ranging from simple, inexpensive oscilloscopes to precision laboratory apparatus.

The tube has a 4 in. diameter flat screen and an overall length of only 12 in. It uses electrostatic focusing and deflection, and is suitable for double symmetrical operation.

The post-deflection accelerator consists of a high-resistance coating applied in the form of a helix to the inside of the bulb. Unlike the normal, single-step accelerator, this helical electrode provides a continuous gradient of acceleration voltage, rising from a relatively low value near the deflector plates to a high final value. By this means pattern distortion is minimised and a higher p.d.a. ratio, up to 4:1 may be used. Thus pre-deflection acceleration may be kept low to ensure high sensitivity, while the final accelerating voltage may be made high to obtain maximum brightness. Under typical operating conditions 'X' and 'Y' sensitivities of, respectively, 30 and 10 V/cm can be achieved with a post-acceleration voltage as high as 4 kV.

The shield between the two pairs of deflection plates is brought-out separately, so that the shield voltage may be adjusted to correct pin-cushion and barrel distortion.

The screen of the DH10-78 is designed specifically for oscilloscopes and uses a high-sensitivity sulphide phosphor giving a bright actinic display. It has blue and yellow components giving, under normal excitation conditions, a green/white fluorescence of medium persistence.

Heater Rating	6·3 V, 300 mA (a.c. or d.c.)
$-V_g$ max.	200 V
$+V_g$ max.	0 V (2 V peak)
V_{a1+a3} max.	3·0 kV
V_{a1+a3} min.	1·0 kV
V_{a2} max.	1·5 kV
p.d.a. voltage max.	8·0 kV
Base	B14A diheptal

Full details may be obtained from Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

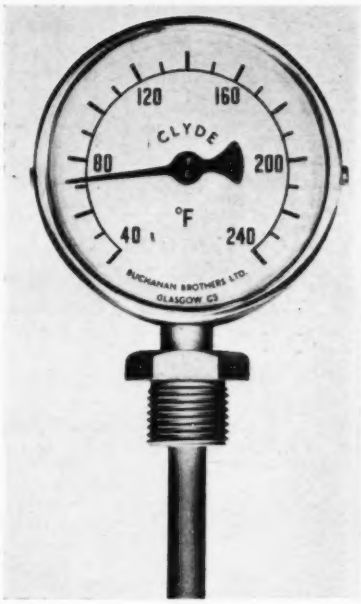
An Improved Electrolytic

A new plastic cased electrolytic possessing greatly improved operating characteristics has been produced by The Plessey Company Limited.

Developed from an original model designed and patented (Patent No. 757,804) by Plessey some years ago, the new electrolytic has been subjected to exhaustive life testing in order to obtain a higher maximum upper temperature limit.

This has been successfully achieved and the resultant up-rating to +70°C now brings this type of electrolytic into line with its metal cased counterpart but with the added advantage of a completely insulated body at no extra cost.

Full details may be obtained from The Plessey Co. Ltd., Ilford, Essex.



Industrial dial thermometer.

Industrial Dial Thermometer Compensated for "Creep"

Designed to replace the brass cased glass thermometer, the "Clyde" V.B. industrial dial thermometer is compensated against "creep" due to the case heating or cooling. The latest models are fitted with the company's new "Easiread" scale which enables readings to be taken at considerable distances. The thermometer consists of a bi-metallic element which operates through a movement. By means of this movement the instrument can be calibrated accurately over its entire range.

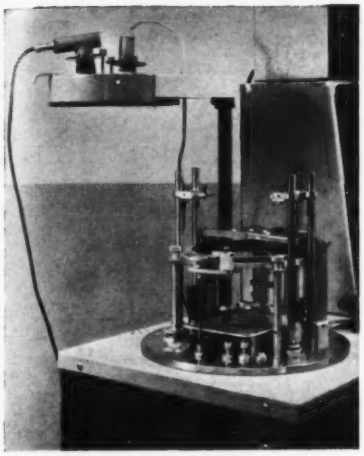
Standard ranges available are 0-300°F and 40-240°F; 0-160°C and 10-120°C. Delivery of standard instruments having a tail length of 2½ in. below the hexagon is ex stock. The price is 36s. 0d. each.

Full details may be obtained from Buchanan Bros. Ltd., 80 Commerce St., Glasgow, C.5.

12E7 Optical Vacuum Coating Plant

The new 12E7 is a scaled down version of the 19VE5. Like the latter, it has been developed specially for single or multi-layer sputtering or evaporated optical films and is ideal for research or small scale work prior to using larger plant.

These films can be deposited either in an upward or downward direction. Coating of this nature is usually in an upward direction on to the under side of the work holder, this method being suitable for large self-supporting areas where total coverage is not required and the article can be supported on a pierced carrier plate. However, for very small areas and where total coverage is required, the films can be deposited downwards by adapting the chamber assembly. A patented sputtering arrangement used in conjunction with the rotary work holder enables two dissimilar metals to be deposited



Base plate assembly of 12E7 optical film vacuum coating plant.

using an a.c. supply and without having to transfer the work. The 12E7 chamber also incorporates a simple beam photometer enabling film thickness to be measured during the actual coating process either by reflectivity or transmission.

This new plant is compact and completely self contained and the selling price is approximately £1,300.

The pumping system for the 12E7 consists of a 4 in. bore oil diffusion pump having a baffled speed of approximately 200 litres per second. This is backed by a "Speedivac" 1SC150A single stage rotary pump with a displacement of five cubic feet per minute. The pumping system is complete with suitable pipework plus manually operated "Speedivalve" for backing and by-pass. Air admission to the chamber and rotary pump is effected by RS1A valves and fine control of air admittance for ionic bombardment and sputtering is obtained by an OS1C needle valve. Vacuum measurement in both the chamber and the roughing system is provided by a combined Pirani/Penning vacuum gauge, the cold cathode ionisation head of the Penning instrument being screwed directly into the vacuum base plate. A VSK1 vacuum switch provides protection by automatically isolating the electrical supply when the work chamber is at atmospheric pressure and a thermosnap switch on the diffusion pump cooling coils protects the pump from over heating should the water supply fail.

H.T. and L.T. supplies are provided on the cabinet, the former by the high tension transformer having a normal rating of 250 milliamps at 3,000 volts, open circuit 5,000 volts. The output from the transformer is fed to the chamber sputtering or cleaning electrodes via a changeover switch operated from the instrument panel. This enables either two pairs of sputtering cathodes or one pair of cathodes and the pair of cleaning electrodes to be operated consecutively without the necessity to transfer connections during the process. Power for the L.T. supply is through a low tension transformer of continuous rating 150 amperes at 10 volts, capable of delivering 200 amperes for short intermittent periods. The low tension service is selected by means of a rotary switch on the control panel.

Full details may be obtained from Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex.

Improved Inspection Gauges

FURTHER developments in the field of industrial inspection gauges by the Amar Tool & Gauge Company Limited have resulted in the production of a range of nitrided plug and gap gauges.

These gauges, which are made in the same sizes as the existing range, have a life of four to five times that of their ordinary counterparts: the plug gauges being available either as single or double ended models.

Exhaustive tests have revealed that one nitrided plug gauge is capable of checking more than 13,000 holes even in such an abrasive material as aluminium alloy. This new nitriding treatment can be applied to all types of Amar gauges according to customer's requirements which, in turn, are dictated by the material the gauges are expected to work in.

The gauges are all made to B.S.S.969/1953 tolerances and incorporate the taper lock fixing device for both plug and handle which is also recommended by the British Standards Institute.

Full details may be obtained from the Amar Works, Grove Road, Chadwell Heath, Essex.

Automatic Control of Industrial Processes by Ferranti Computer

THE first transistor electronic digital computer designed to provide fully automatic control of many industrial processes is being developed by Ferranti Ltd. It is about the size of two small office filing cabinets and the first production models are expected to be available in 1960.

This will be the first time that a computer of this type designed for process control will use transistors instead of the conventional thermionic valve, and, as a result, will only measure approximately 4 ft × 4 ft × 2 ft.

At present in the prototype stage it is technically known as the PCTC (Process Control Transistor Computer). The transistor logical circuits in the computer have been thoroughly tested and an experimental model has controlled a machine which simulates a plant process for more than 2,000 hours' operation without component failure. Additional vibration and temperature tests have also been carried out to simulate the most rigorous conditions the computer is likely to meet in industrial use.

The computer is being specifically developed as the centre unit in control systems for a variety of industrial processes, such as may be found in the power, chemical, oil, gas and steel industries. Babcock & Wilcox Limited and their associates, Bailey Meters & Controls Ltd., are currently investigating with Ferranti Ltd. the feasibility of using this new computer for the control of boilers during start-up and shut-down.

Probably the most important factor is that this computer opens the way for fully automatic control of many industrial processes because it can operate continuously for long periods under arduous industrial conditions without the necessity to regularly shut-down for preventative maintenance.

Not only will this type of computer calculate alterations that have to be made in any process, but also provide the control signals to automatically carry out these alterations.

The price of the new computer will probably be in the range of £20,000—£50,000, depending on the size of the installation.

Full details may be obtained from Ferranti Ltd., Hollinwood, Lancashire.

Atomic Energy Temperature Test Rig

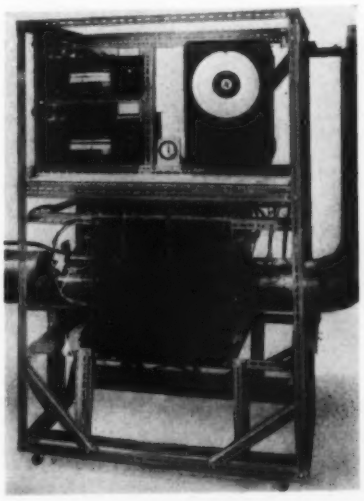
A TEST RIG incorporating the graphite blocks used in reactor construction has recently been completed by the Foster Instrument Co. Ltd. for the United Kingdom Atomic Energy Authority.

The research tests included the measurement of temperature gradients in all planes through varying thicknesses of graphite, surface temperatures in the fuel element and isotope channels and time constants of various types of thermocouples.

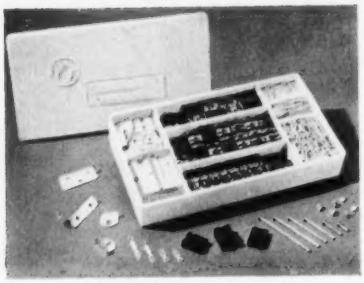
These tests were carried out under both static and dynamic conditions and under the latter air flow rates of 37,000 to 87,000 cubic feet per hour were required necessitating the development of special types of contact thermocouples. The heat source was created from electrical blanket heaters on all sides of the block assembly and special cartridge and vee-formed heater elements mounted on dummy fuel cans. By controlling air flow rates and temperature, operational conditions representative of any section throughout the entire depth of the reactor were simulated.

The above tests and the results obtained are considered to be of vital importance towards improved instrumentation of reactors.

Further information can be obtained from Foster Instrument Co. Ltd., Letchworth, Herts.



Test rig incorporating graphite blocks.



NSF-Varicon connector kit.

Varicon Connector Kit

NSF-Varicon connectors are now available in "Kit" form. With each kit, and using only a screwdriver, it is possible to build a wide variety of these electrical connectors in various sizes and combinations, as and when they are required. The finished assembly is a precision connector of high quality and appearance. Accessories, such as covers, recessed housings and handles, are available for single and double tier connectors, and can be purchased as additional items to the Varicon kit. A list of parts and clear pictorial instructions for assembly are included with each kit.

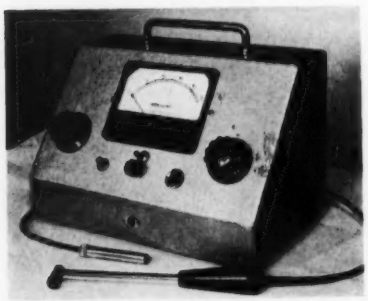
Full details are obtainable from N.S.F. Ltd., 31-32 Alfred Place, London, W.C.1.

Elcotector

THE primary use of the Elcotector is for all types of coating measurements on components. It is capable of measuring the thickness of most metallic and non-metallic foils both in the static and moving state and thus it can be applied to the production run to give continuous readings of thickness as material is produced.

The following are examples of its capacities.

(1) It will measure any type of coating, metallic or otherwise, on a ferrous base.
(2) It will measure non-metallic coatings on most metal bases and some metallic coatings provided the specific resistance of the coating and the base is different.
(3) It is capable of comparing the degree of hardness of steel components.
(4) It will differentiate between the variations in ferrous contents in steel.
(5) It will measure the thickness of non-ferrous foils.



Elcotector.

(6) It will measure any type of metallic and non-metallic film providing that with the latter a metal plate can be introduced at the reverse side at the point of measurement.
(7) It will differentiate between various types of alloys.
(8) It may be used for surface crack detection.

The Elcotector is a new development of the use of the eddy current principle. The device makes use of the fact that the electrical characteristics of a coil are influenced in proportion to its proximity to a metal surface. Under suitable conditions a meter is capable of translating these changes in the coil into measurements of non-metallic coating on metal. This coil is also influenced by the type and structure of the metal, i.e., these changes can be translated into metal film thickness, metal hardness and like measurements.

The coil in the case of the Elcotector is situated in the head of the probe which is presented to the surface under test. Two types of probe are available—one in the form of a short pencil for general purposes, the other with a short head and angular extension to enable its use in narrow confined spaces, these two being used for hand checking purposes only. For continuous strip measurement special probes can be produced capable of accommodation on any specific machine. They can be housed in p.t.f.e. frictionless material and so lightly balanced as not to affect even the most delicate material. Hollow cup or pot coils are provided for repetitive hardness measurement of such small tools as drills, plug gauges, taps, steel balls, etc.

The sensitivity of the unit varies according to the type of work and can be adjusted over very wide limits.

The loading of the unit is approximately 55 watts. Weight with lead and probe 15 lb.

The Elcotector is priced at £160 0s. 0d. net, including packing and delivery. This price includes either one of the two probes described above.

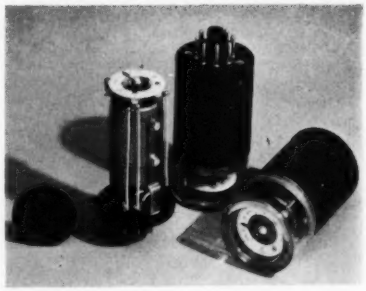
Full details may be obtained from East Lancashire Chemical Co. Ltd., Fairfield, Manchester.

Leland Leroux Sensitact Precision Measuring Relays

DESIGNED and developed by the old-established firm of Brion Leroux & Cie., of Paris, these relays are now available in the United Kingdom and British Commonwealth and Empire from Leland Instruments Limited.

The relay consists of a galvanometer movement, complete with scale and pointer, to which has been added a moving contact. On each side of this are arranged two fully adjustable contacts, adjustable over the full range of the scale.

Leland Leroux Sensitact relays are fully shielded and are available in 16 different models, with moving coil resistances ranging from 2·5 ohms to 7,500 ohms, and with full scale deflection current ratings ranging from 10 mA down to 0·02 mA. In the case of the most sensitive model the minimum change of control power necessary to make or break contact is of the order of 0·05 microwatts (five-hundredths of a microwatt). The relay contacts have a power handling capacity of 200 milliwatts. Each of the 16 models is available either as a maximum-minimum indicator with scale covering 90° and calibrated 0—100 divisions, or in centre-zero form with scale calibrated 50—0—50 divisions.



Sensitact precision measuring relays.

Full details may be obtained from Leland Instruments Ltd., 22-23 Millbank, London, S.W.1.

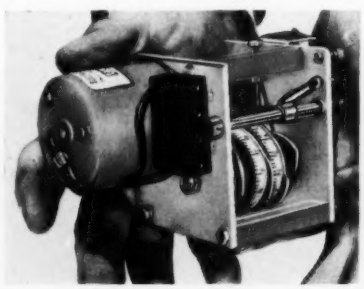
Miniature Automatic Synchronous Timer Type AMS

TIMER Type AMS consists of an electro-magnetically-operated clutch, continuously and independently adjustable calibrated time setting dials each associated with a snap action changeover switch, and adjustable mechanism resetting the timer within a half second, and a miniature synchronous motor.

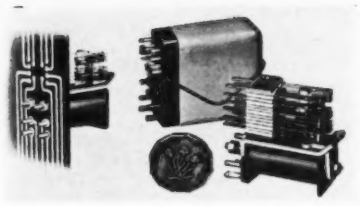
The timer is capable of automatic reset at the end of a pre-determined timing sequence, or of repeating preset timing cycles continuously with automatic reset on power failure or shut down only.

Standard operating voltage 230 V or 110 V, 50 or 60 c/s, 1 phase a.c. Step up or step down transformers can be supplied for operation on higher or lower a.c. supply. D.c./a.c. conversion units are available for operation of timer Type AMS from 6-220 V, d.c. Standard time ranges are 0-30 seconds, 0-60 seconds, 0-5 minutes, 0-10 minutes, 0-30 minutes, 0-60 minutes, 0-4 hours, 0-12 hours, 0-24 hours, 0-48 hours. Other time ranges are available on application. The prices range from £7 15s. 0d. and the delivery time is 5/7 weeks.

Full details may be obtained from Electrical Remote Control Co. Ltd., The Fairway, Bush Fair, Harlow, Essex.



Elremco synchronous timer.



P.3 sub-miniature "3,000-Type" relay.

P.3 Sub-miniature "3,000-Type" Relay

A MARK III version of the P.3 relay has just been developed by D. Robinson & Co.

In addition to various small changes, mostly concerned with life (tests have already passed twenty million operations), the P.3 can now be fitted with:—

(a) heavy duty contacts rated at 5 A at 240 V a.c. or 24 V d.c. The action can be M or B and the contact material permits the switching of moderately inductive loads.

(b) K or inherent make-before-break light duty change-over contacts.

Up to six sets of contacts can be fitted of mixed type; that is, each set can be of either of the above type or of twin construction (as used in the big 3,000-type) with M, B or C action and of various metals. The P.3 can be supplied suitable for direct mounting to a printed circuit.

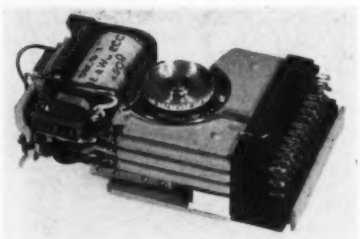
Other features of the P.3 are that the coil can be of up to 9,000 ohms, double wound or slugged and requires as little as a tenth watt for one make and up to 1½ watts for 6 change-over. A residual screw can be fitted allowing the differential to be set between 20% and 60% and the whole relay can stand an ambient temperature of 100°C, if specified. The maximum dimensions are 1·7 in. × 1·5 in. × 0·765 in.

Full details are available from D. Robinson & Co., 717 London Road, Hounslow, Middlesex.

Miniature Uniselector for Automatic Systems

A SMALL plug-in uniselector switch with 36 outlets and measuring 3¾ in. by 2 $\frac{5}{16}$ in. by 1 $\frac{1}{32}$ in. is introduced by Siemens Edison Swan Ltd. for use in automatic systems. It weighs only 12 ounces complete. It will operate for two million revolutions without need for readjustment, and has a working life of at least eight million revolutions before replacement of any part.

The miniature uniselector is designed for operation in 22 volt or 50 volt circuits in its standard versions and incorporates its own spark quench device.



Miniature uniselector.

There are three main elements: a driving mechanism and wiper assembly; a bank of contacts over which the wipers search at 60 steps a second; and a jack which is pre-wired and assembled to the mounting enabling the uniselector mechanism to be plugged in and out without disturbing any wiring.

The driving mechanism is mounted on a steel side plate and has all parts readily accessible. It is operated by a ratchet and pawl system of the reverse drive type having a single driving magnet and a single break action interrupter spring set with tungsten contacts. The wiper assembly comprises three pairs of nickel silver treble-ended wipers of either bridging or non-bridging type. There is a number disc.

The bank comprises 36 contact segments arranged in three levels. The design of the bank is such that one of the arms of the wiper assembly is always touching a specially fitted solid contact segment, and this arrangement enables feeder springs to be dispensed with.

A feature that should hold wide appeal for the engineer is that all wiring terminations to both the driving mechanism and the contact bank are made by means of a 42-point plug and jack. When plugged in, the uniselector is securely held in position by a spring clip.

This miniature uniselector has been standardised by the British Post Office.

Full details may be obtained from Siemens Edison Swan Ltd., 155 Charing Cross Road, London, W.C.2.

Smoke Alarm Equipment

THE Londex smoke alarm unit Type SAU is built to comply with B.S.S.2740 and is suitable where the light beam through the smoke will not exceed 10 ft.

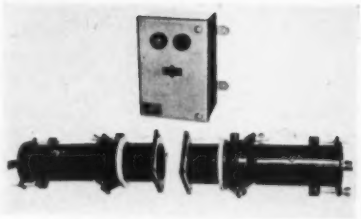
The projector throws a parallel light beam across the flue on to the receiver head. Obscuration of the light beam by smoke causes the current of the photo-electric cell to vary according to the density of the smoke. When a predetermined smoke density has been reached, the relay in the control unit operates the output contact and also extinguishes the green lamp and illuminates the red lamp mounted in the control unit. In addition a small lamp fitted to the receiver head is lit, this being provided to facilitate initial setting up of the equipment. The receiver head also incorporates an adjustable iris to compensate for various flue diameters.

A switch in the control unit allows periodical checking to ensure that the alarm circuit is operating at the required smoke density.

The inter-connecting cables between the projector and receiver heads and the control unit may be up to 150 ft. The equipment will operate from a mains supply of 190-260 volts, 50 cycles.

After the instrument has been installed the alarm will be required to operate at a certain point and this must be set in relation to the amount of smoke emitted from the top of the chimney, the exact method being given in B.S.S.2742.

Negative pressure should exist in the chimney at the position where the photo-cell and projector heads are installed. This is to ensure that air is drawn over the lenses into the chimney, keeping them clean.



Smoke alarm equipment.

If the heads cannot be mounted at a position where negative pressure exists in the chimney, it would be necessary for a compressed air supply to be made available on site. The compressed air would be connected to pressure entries on the photo-cell and projector head, thus ensuring that air is blown over the lenses to keep them clean.

The smoke density equipment Type SD provides a continuous monitoring of the smoke position by means of a meter, a recorder can also be provided to supply a printed day-to-day record.

The operating principle is similar to that of the smoke alarm unit.

One meter is provided to give a continuous indication over the full scale of obscuration; the second meter is provided solely as a means of operating maximum and minimum level contacts. The contacts on this latter meter can be set at will to the required densities.

The standard unit is suitable for supply voltages between 190 and 260 V, the consumption being about 150 watts. Connecting leads between the projector or receiver head and the control unit may be up to 200 feet in length.

Full details may be obtained from Londex Ltd., 207 Anerley Road, London, S.E.20.

New High Efficiency Scintillation Counter

THE SC/LP scintillation counter now being marketed by Panax Equipment Ltd. has been developed for the counting of millimicrocurie quantities of very low-energy beta-radiation emitters such as tritium and carbon-14. The counter is intended primarily for use with liquid phosphors but can also be converted to accommodate plastic phosphors and sodium iodide crystals. The equipment consists of a 1½ in. thick (minimum) lead castle fitted with a light-tight door which is interlocked with an EHT switch and a

Scintillation counter.

shutter assembly to protect the photomultiplier and to prevent external light increasing the background count.

Normally, a standard 30 ml glass jar is used as a container for the liquid phosphor into which the radioactive source to be counted is placed: since the shutter provided opens automatically when the castle door is closed and operates a microswitch, samples can be changed in normal room lighting while maintaining a low level of background counts. When in position in the castle, the bottom surface of the glass container is adjacent to the sensitive surface of the photomultiplier tube and a good optical contact is maintained by means of a liquid light guide. The shutter assembly can be replaced by a crystal mount which will accept 1½ in. diameter by 1 in. sodium iodide crystals or plastic phosphors of similar dimensions: by inverting the unit, liquid and solid samples can be investigated with minimum air gap between sample and detector. The high efficiency counting of low-energy beta-emitters in other forms can also be carried out with this equipment.

For counting purposes, the counter is used in conjunction with a linear amplifier and suitable scaling apparatus incorporating discriminator and EHT supplies. Efficiencies of 10% for tritium and 50% for carbon-14 have been obtained at room temperature, but higher counting efficiencies can be achieved by cooling the castle in a standard refrigerator.

Full details may be obtained from Panax Equipment Ltd., Holmethorpe Industrial Estate, Redhill, Surrey.

Nife Switch Tripping Equipment

A REDESIGNED range of self-contained steelclad tripping units has been introduced by Nife Batteries, of Redditch, Worcestershire, in line with modern switch-gear developments.

Each of the new units includes a battery of the Nife nickel cadmium alkaline type. The battery is arranged in a single tier, which allows extra space above the battery, to facilitate inspection. A compartment is also provided beneath the battery for storage of tools and accessories.

The dual scale on the charge ammeter enables low and high rate charges to be read easily. Four rates of low rate charge and one rate of high rate charge can be selected by means of independent fixed resistances. A warning lamp gives visual indication of the high rate charge.

Full details are available from the firm at the above address.

Burst Slug Detection System

THE nuclear power reactors at present being constructed in this country for the Central Electricity Generating Board are of the gas cooled graphite moderated type. In these reactors one of the major instrumentation requirements is the rapid detection of faulty fuel elements. The systems being adopted are developments of the basic Calder Hall method.

The coolant gas from numerous points within the reactor is regularly sampled. Ionised radioactive particles are electrostatically precipitated on a wire and exposed, after a definite delay, for a fixed period to a scintillation counter. This produces a pulse for every radioactive event detected. These pulses are summated by a ratemeter. The output of the ratemeter is compared with a preset reference and recorded graphically. If the reference for a particular point is exceeded an alarm is given. In addition the value and its location is automatically printed out at the same time.

Considerable care has to be taken in the design of such a system to ensure that it has maximum reliability. Self-checking facilities must be provided and the "fail to warning" concept used throughout. The present estimated life of these stations is over twenty years and the instruments must be designed with this in view.

Marconi Instruments Ltd. are developing the Faulty Fuel Element Detection System for the nuclear power station under construction at Hinkley Point in Somerset. The photograph shows a prototype proving system in their laboratories at St. Albans. In the left-hand side of the panel below is the new Marconi

Data handling equipment for the detection of faulty fuel cans in nuclear reactors.

count analyser TF 1253. This unit will compare the ratemeter output with the preset reference level and initiate alarms if the value is exceeded. In the lower portion of the rack the scanning and synchronising components are also on test.

Full details may be obtained from Marconi Instruments Limited, St. Albans, Hertfordshire, England.

Infra-red Radiation Pyrometer Type TRP

THE pyrometer comprises two units: the viewing head and the control unit. The infra-red sensitive element, housed in the viewing head, is a lead-sulphide cell, located behind a rotating "chopper", or serrated disc, in such a manner that it is irradiated alternately by the heated surface under test and by a tungsten-filament comparison-lamp. An alternating voltage is thus produced across the cell; the value of this voltage will be zero if the level of radiation from the two sources is the same.

The circuit in the control unit adjusts the comparison-lamp current so that the alternating voltage across the lead-sulphide cell is kept at a minimum. This current-adjustment is entirely automatic, requiring no attention from the operator; and it is the lamp current, indicated on the meter at the front of the unit, which is a function of the temperature of the surface under test. The cell is thus used as a "null" detector, and the small inherent "drift" in its sensitivity is unimportant.

The incoming infra-red radiation is focused on to the lead-sulphide cell by an objective lens, mounted at the inner end of the lens tube. The sensitivity of the pyrometer is such that it is necessary when measuring high temperatures to attenuate the incoming radiation to bring the meter current within the range of the instrument. For this purpose, two removable "stops", or masks, are provided for insertion into the lens tube; one reduces the aperture area by ten and the other by one hundred. Further attenuation can be obtained by interposing heat-absorbing glass (viz., an infra-red filter) between the surface under test and the viewing head.

Use of the stops provides three temperature ranges: 150°C—400°C on full aperture; 300°C—600°C on the medium aperture stop; and 400°C—1200°C on the small aperture. The last range can be extended to 2000°C by the use of an infra-red filter. The lowest range is used for bodies at "black" heat.

The viewing head is provided with a view-finding periscope, in which a movable mirror behind the objective lens deflects the incoming rays through a magnifying lens; a circle indicates the area of the surface which will irradiate the lead-sulphide cell. The position of the mirror is controlled from the side of the viewing head. To focus on a surface, the control is turned to the position marked "focus"; it must be returned to "cell" before measurements can be made. The eyepiece of the periscope is located under a sliding shutter on top of the unit.

The smallest area which can be viewed is a circle 0·4 in. diameter; for this, the lens tube, fully extended, must be as close as possible without actually touching the surface under test. The diameter of the circular area increases by 1 in. for each foot increase of distance.

As the reading depends on so many independent variables, the instrument must be calibrated for each application under similar conditions to those in which it is to be used. Once the instrument has been calibrated for a given material and surface finish, at a given distance, no further calibration is necessary unless any of these conditions are changed.

The meter-reading is erratic unless there is sufficient radiation to give about 30% of full-scale deflection on the meter, because, at low signal levels, the signal-to-noise ratio from the cell is small, and the circuit is incapable of providing an accurate balance.

A jack-socket at the back of the control unit allows an external meter, a recorder, or temperature-controlled contacts to be connected in series with the comparison lamp and the control-unit meter. The resistance of the external load must not

exceed 220 ohms, otherwise the current in the circuit will be insufficient to give full-scale deflection—40 milliamp—on the meter. Details of a suitable recorder will be forwarded on request.

To facilitate the positioning of the viewing head, it is provided with a screwed socket in the base, suitable for mounting on a camera tripod.

The equipment requires a power supply of 200/260 volts, single-phase, 50 cycles, a.c.; the power consumption is 12 watts. To reduce bulk and weight, transistors are used as far as possible in the pyrometer circuits.

Full details may be obtained from The British Thomson - Houston Co. Ltd., Rugby.

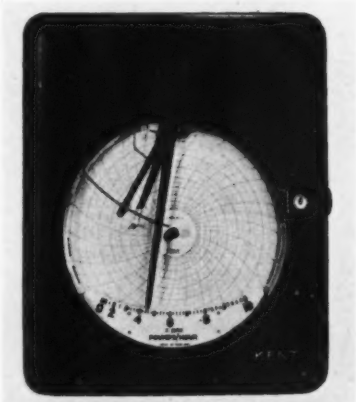
New Mercuryless Instrument

GEORGE KENT LTD. announce the addition to their "Commander" range of the new Kent-Barton mercuryless diaphragm instrument for the measurement of differential pressures in six maximum ranges, and up to 2,500 lb/in² working pressure.

These instruments, available intrinsically as circular-chart recorders, sector-scale indicators and circular-scale indicators, incorporate the "Barton" patented rupture - proof differential unit, which, although employing sensitive bellows for its actuating element, may be subjected to pressure differences equivalent to the pressure rating of the instrument without damage. Full line pressure can be applied across the bellows unit in either direction without damage, irrespective of the differential-pressure range of the instrument, owing to the valve in each bellows.

The torque-tube drive for conveying bellows movement to the instrument-index mechanism is leakage-free and requires no periodic lubrication, being virtually frictionless for the life of the instrument. Only the bellows exteriors are exposed to the metered fluid, and the unit is therefore completely self-draining or venting; is without pockets to trap condensates and sediment formations; has no small tubes or other restrictions to interfere with its function.

Full details may be obtained from George Kent Ltd., Luton, Beds.



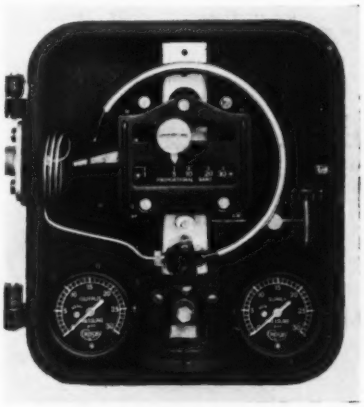
Kent-Barton mercuryless instrument.

Mason Neilan Proportional Air-operated Pressure Controller

THE new Mason Neilan Model No. 2807 air-operated pressure controller is normally used mounted directly on the yoke of the control valve, but can also be used remotely surface mounted.

This instrument has many features basically similar to the No. 2707, but amongst the additional advantages is a pilot relay of the non-bleed slack diaphragm type which has a large air capacity and enables a much greater valve stroking speed to be achieved. This pilot valve is interchangeable with that of the 12,800 Series Mason Neilan level controller which simplifies the spares problem.

The proportional mechanism incorporates a bellows operated negative feedback system giving maximum sensitivity and reproducibility. With this proportional mechanism the proportional band can be adjusted as low as 1% of the instrument range, thus enabling the controlled pressure to be kept within very close limits even when wide load changes are experienced.



Proportional air-operated pressure controller.

The pressure element, which is available in bronze or stainless steel, can be either of the bourdon tube or bellows type, covering all ranges from full vacuum up to 10,000 p.s.i.

The whole instrument is sturdy and simple to operate and maintain; it is suitable for outdoor use in all climates and will withstand over-pressure up to 50% of the range.

The normal supply pressure is 20 p.s.i. with the international standard output signal of 3-15 p.s.i.

Full details may be obtained from Crosby Valve & Engineering Co. Ltd., Crosby Works, Ealing Road, Wembley, Middlesex.

Newton-Victor PMX Eye Magnet

THE Newton-Victor PMX magnet, for the removal of ferromagnetic bodies from the eye, is capable of exerting an attractive force of over 100 times the weight of the attracted particle; this is two to three times better than is possible with existing magnets.

PMX eye magnet.

Special features of the PMX magnet are the inclusion in the iron circuit of a base-plate and magnetic shroud partially enclosing the copper windings, and the use of special cobalt-iron, with a high saturation flux density, for the magnetic core.

As a result, with the No. 1 pole tip energised at 4 kW input, the attractive force, at 2·5 cm from the eye, is 104 times the weight of the particle attracted. This compares very favourably with the more powerful of the pedestal types, for which 40 times is considered a high ratio.

With such a high powered instrument the energised time has to be limited to avoid undue heating of the windings. The PMX magnet can be energised for some 20 seconds without risk of damage, and to ensure an ample margin of safety, with a minimum number of cooling periods, a protective device is incorporated, which automatically disconnects the electrical supply before the time limit is reached. A push-button enables this thermal protective device to be reset when necessary.

Full details may be obtained from Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17.

Solartron X-ray Spectrometer XZ 736

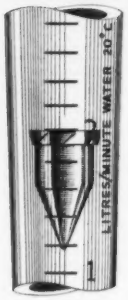
THE Solartron automatic X-ray fluorescent spectrometer XZ 736 provides a new, rapid and accurate method of material analysis. It identifies the various elements in mixtures, alloys and compounds, whether they be in solid, powdered or liquid form. This method of analysis is essentially non-destructive and the sample leaves the machine unchanged.

The XZ 736 spectrometer may be used to analyse matter in any form of chemical compound. The result may be presented as a curve on a recorder chart, or as a printed record of the number of quanta counted in a given time at each Bragg angle examined. Either method of presentation may be selected at will, and it is also possible to generate a signal which will operate alarms or control a chemical process. The equipment may therefore be used for process control, performing a continuous analysis of the 'end-product' and automatically making suitable adjustments to the process.

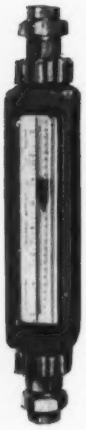
ROTAMETER

FLUID MEASUREMENT AND CONTROL

FLOW-DENSITY-LEVEL

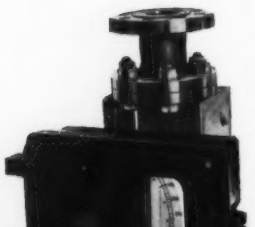


A typical glass tube and float



Type 900 Metric Series (for non-corrosive service)

Type 907 Metric Series



Type 400L Pneumatic Transmitting Rotameter with lagged body

FLOW MEASUREMENT

The Rotameter type of variable-area flowmeter is applicable to most of the flow measurement problems which arise in industry and research.

It is particularly useful in the chemical industry because it can be constructed in a variety of corrosion-resisting materials.

When the working conditions are appropriate the direct-reading glass-tube Rotameter is a first choice on account of its inherent simplicity. For work which requires high accuracy it may be calibrated individually for the fluid which has to be handled, or if a lower degree of accuracy can be tolerated an instrument chosen from the interchangeable "Metric" series shows advantages in respect of lower cost and quick delivery. The new mountings, Types 907 and 914, offer in addition, interchangeable gland packing, including P.T.F.E., with robust corrosion-resisting structural parts.

Glass-tube Rotameters are used to measure flows between:

10 ccs/Min and 2,600 L/Min of gases

or between:

1 cc/Min and 225 L/Min of liquids.

Rotameters are also made in which the tapered metering tube is of metal. These may be direct reading, or they may have transmitting mechanisms (electric or pneumatic) giving signals which will operate recorders or controllers. Some designs will work at high pressures and temperatures (e.g., 5,000 p.s.i.g. or 500°C).

A large metal-tube Rotameter will measure liquid flows up to 5,000 L/Min. Several types of alarm are available to signal changes in flow beyond desired limits.

LIQUID DENSITY MEASUREMENT

The "RM" Density Meter provides a continuous indication of the density of a liquid flowing through it, this indication taking the form of either an electric or a pneumatic signal which can be displayed upon an appropriate instrument. It will handle most corrosive liquids and is particularly successful in dealing with muds and slurries (lime, china clay, etc.).

At the maximum sensitivity, full-scale deflection corresponds to a density change of 0·1 gm/ml, and variations of ·001 gm/ml can be detected with certainty.

On account of its small measurement lag, the "RM" Density Meter gives excellent results in automatic density control systems. A new design of Density Meter for use with clean liquids is now available which has a maximum sensitivity of 0·03 gm/ml for full-scale deflection and can accommodate line pressures up to 75 p.s.i.g.

The "RM" Density Meter

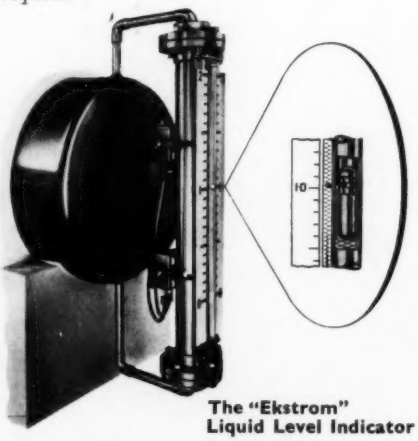
"EKSTROM" LIQUID LEVEL INDICATOR

The "Ekstrom" level gauge consists of a tube of non-magnetic material (e.g., stainless steel) containing a magnetised float which rises and falls with changes in the liquid level. Adjacent to this is a glass tube in which is a hollow iron ball immersed in butanol. The ball forms in effect a weightless pointer and follows the movements of the magnetised float.

Accidental breakage of the glass indicator tube does not involve any loss of plant fluid, and the "Ekstrom" level gauge is therefore, suitable for use on tanks containing dangerous or corrosive liquids.

These gauges can be supplied to work for most liquids, and are often made to cover level changes of 18 feet. They can be provided with magnetically-operated electric or pneumatic switches for high or low level alarm purposes or for pump control.

Catalogue R.P.2000/I is available on request.



The "Ekstrom" Liquid Level Indicator

ROTAMETER MANUFACTURING CO. LIMITED

PURLEY WAY · CROYDON · SURREY

Telephone: CROydon 3816

X-ray source—Machlett OEG60 X-ray tube operating at 60 KV and at 40 mA. The tube current is stabilised to within 0·1 per cent.

Crystal—Calcite, lithium fluoride, and others.

Speed of operation—Depends largely on the required accuracy. Counting times vary from 10 sec to several minutes. A guide to maximum speed is given by the fact that re-positioning of the crystal and the counter takes less than 5 sec, so a rate of 15 sec per element can be achieved.

Sensitivity—Sensitivity is a function of the basic analysis problem involved. In favourable cases 1 part in 10^6 can be detected.

Accuracy—Proportional to the square root of the number of counts taken. 0·3 per cent of content is quite common.

Specimen—Specimens should have a surface area of ½ to 1 sq in. and should be of similar shape. Liquids and powders for analysis may be contained in special low absorption cells.

Programming—Up to 24 transmitters in multiples of three can be supplied and any number of these may be used in programming the equipment, the remainder being switched off.

Limitations—In its present form, the apparatus will give good results on elements with atomic numbers above 20. An evacuated chamber is under development so that elements lower in the periodic table may be estimated. This will be an improvement which can be added to the present equipment.

Price—£9,500 for nine-channel equipment.

Full details may be obtained from, Solartron Industrial Controls Limited, Goodwyns Place, Tower Hill, Dorking, Surrey.

The Dekameter

THE Wissenschaftlich-Technischen Werkstätten, of Weilheim, Upper Bavaria, have introduced Dekameters on to the market. These instruments incorporate many years of experience in the field of dielectric spectroscopy and cover almost the entire frequency range up to microwaves. The different types of Dekameter produced enable dielectric data to be determined to a high degree of accuracy. The substance to be investigated is introduced into a capacitor. The shape of this capacitor depends on the type of substance being handled, i.e., gases, liquids or solid materials in powdered, granular, sheet form, etc. The analysers which are normally produced from nickel-plated brass can also be supplied in glass, special steels, or platinum for handling corrosive substances. The temperature range which normally covers −20 to +160°C can be extended to include very low temperatures or high ones up to 1000°C.

Dekameter.

Applications of dielectric spectroscopy are varied but are of chief importance in quantitative analysis. Moisture determinations in almost all substances can be carried out quickly and accurately using this technique.

The instrument can be handled by unskilled labour. It can be used in conjunction with the Elograph type Elo 2 to make continuous measurement and recordings. Dekameters are available with variable frequency ranges and can be used to determine permeability and magnetic loss as well as dielectric constant.

A special apparatus has been developed by the same firm to evaluate the electrical dipole moment of molecules. The instrument is known as the Dipolemeter, type DM 01.

Full details of these instruments may be obtained from Wissenschaftlich-Technischen Werkstätten, Weilheim, Upper Bavaria, Germany.

"Minnow" pump.

New Small Versatile Pump

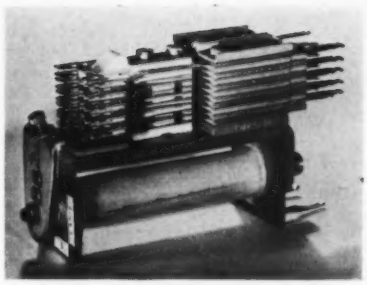
APPLETON & HOWARD LTD., of St. Helens, Lancashire, have added a new pump to their "Gush" series. The "Minnow" measures only 7¼ in. by 3⅜ in. by 5¼ in. and weighs 5¼ lb. It is of the centrifugal type complete with a direct mounted motor fitted with a guard. The pump components and the motor are held in a die-cast aluminium frame with support feet. It can, therefore, be mounted on bench, or panel, or incorporated in a packaged unit. The suction and discharge branches are suitable for ¾ in. bore rubber or plastic hose.

The motor is of the shaded pole type suitable for an electrical supply of 230-250 volts, single phase, 50 cycles, or 50 or 100 volts, 50 or 60 cycles a.c. It has an automatic resetting thermal overload device to guard against the possibility of a winding failure.

Full details may be obtained from the above firm.

Ten Contact Units on One Relay

A GREATER number of contact units than has ever been accommodated on a standard 3,000-type relay is provided on the new comb relay introduced by Siemens Edison Swan Ltd. Up to ten contact actions may be fitted.



Comb relay with ten contact actions.

The new relay is a development of the standard 3000-type relay as used by the British Post Office and other administrations and users for well over a quarter of a century. It has been designed to give a mechanical life of 100 million operations without need for readjustment, whilst retaining the basic characteristics of the 3000-type relay.

The chief advance in the new design is the replacement of the spring set lifting pins by a lifting comb of synthetic resin-bonded paper which bears directly on the metal of the armature, without the use of keramot lifting studs. Exhaustive life tests have shown that this arrangement gives less mechanical wear and reduces the frequency of readjustment and eventual replacement.

At the same time a number of ancillary modifications have been made to suit the new lifting arrangements. The radii of the yoke knife-edge and armature have been increased to give improved seating. Diameters of the armature back-stop and residual screw are increased and given a slightly domed striking surface that greatly increases their working life. The buffer block has been lengthened to bring the steps of the springs nearer the actual contacts, giving an increased buffer block lift.

The relay can be used on normal mains voltage up to 250 volts as a result of replacing the metal lifting studs by the synthetic comb. A further improvement in this direction has been achieved by increasing the width of separators between springs.

Spring-sets are available built-up from any combination of make - and - break, make, break and changeover actions, up to a maximum loading equivalent to ten make actions.

The comb relay has been adopted by the British Post Office as the standard relay for applications where 500,000 or more operations per year are envisaged.

Full details may be obtained from Siemens Edison Swan Ltd., 155 Charing Cross Road, London, W.C.2.

Video Noise Level Meter

THIS instrument has been adopted by the Planning and Installation Department of the B.B.C. as the standard instrument for measurement of signal-to-noise ratio on their television link circuits.

The instrument deals with the measurement of the type of noise similar in nature to thermal noise, but of higher amplitude, caused by transmission systems and which

Video noise level meter.

can limit the use of signals and cause television link picture definition to suffer. Formerly this has been assessed by an oscilloscope method which depends on the skill of the operator and such factors as trace brightness and speed. Here the noise is fed through two attenuators, switching in 10 and 2 dB steps, to the input of a video amplifier. The output of the amplifier is fed through a cathode-follower to the mean square detector which in turn feeds a moving-coil meter calibrated from +1 to −10 dB.

The meter is switched to monitor the output as a built-in calibration oscillator, which can be switched into the input of the instrument as well as the output from the detector. In this way the instrument is calibrated internally for each measurement made, and provision is made by switching the output of the calibration oscillator for setting up the amplifier gain, and checking the law of the system.

Measuring range 20 log signal (r.m.s.)/noise (r.m.s.) = 0 to −60 dB.

Video bandwidth 10 kc/s to 1·5, 3, 6, or 10 Mc/s switchable.

The response is flat from 10 kc/s to the stated frequencies, above these frequencies the cut-off is extremely sharp.

Input impedance 75Ω.

Calibration level 0·353 V r.m.s. sine wave.

Accuracy ± 1 dB.

Full details may be obtained from Wayne Kerr Laboratories Ltd., Sycamore Grove, New Malden, Surrey.

Sunvic Temperature Transmitter

LATEST version of the Sunvic pneumatic temperature transmitter uses high purity helium as filling gas in the thermal system.

Helium has been selected for several reasons. Firstly, it is completely inert chemically and damage to the bulb can have no adverse effect on a process, even in the case of explosives or food. Secondly, the thermal conductivity of helium is good, ensuring rapid response of the instrument to changes in temperature. Moreover, use of helium makes it possible to test the complete thermal system in a mass spectrometer, so that even the most minute leak can be unerringly detected. This, combined with the fact that the thermal system is filled at comparatively low pressure, so that volumetric changes of the bulb at high temperatures are reduced to a minimum, ensures excellent long-term stability.

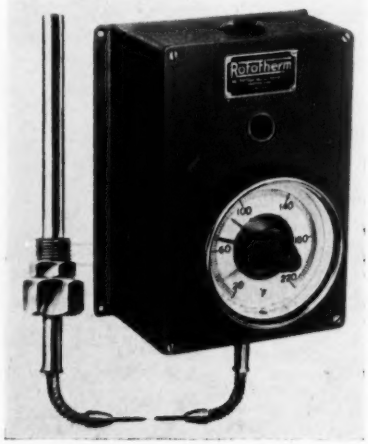
The system is inherently linear as it is a true constant-volume thermometer, and does not permit any changes in temperature.

Construction is extremely simple; no beams, pivots, links or bearings are used, so that wear and friction are eliminated and dead-spot and hysteresis are at a low level.

Thermal systems are of copper or stainless steel; bulbs are available in a variety of forms and sizes. Copper bulbs will withstand 1,000 p.s.i. static pressure, and stainless steel bulbs up to 1,500 p.s.i. Spans from 50°F (30°C) to 900°F (500°C) can be covered, and no "standard" ranges are offered, each instrument being made to customer's requirement.

Since the filling medium is high purity helium very low temperatures indeed can be measured, and the thermometer is sensitive to changes in measured temperature of the order of 0·01% of range.

Full details may be obtained from Sunvic Controls Ltd., Eastern Industrial Estate, Harlow, Essex.



Indicating temperature controllers.

Indicating Temperature Controllers

THE Rototherm indicating temperature controllers comprise a mercury-in-steel actuated 4 in. dial thermometer with control unit having one temperature operated pointer and one or two adjustable pointers which can be set to "make" and/or "break". Standard energising coils operate on 100 to 440 volts a.c. 50 c/s. An advanced design mercury relay switch is incorporated with contact loadings of 30 A, 240 V a.c., for 1, 2 or 3 pole. Minimum differential is ±0·5% of scale range. Switch contacts can be set normally open, normally closed or change-over. Any temperature range from −20°F to +1000°F with minimum coverage of 50°F (30°C) can be provided. Standard bulb is mild steel, ½ in. diameter screwed ½ in. B.S.P. with copper sheathed capillary. Other materials and separable pockets are available.

Full details may be obtained from The British Rototherm Co. Ltd., Merton Abbey, London, S.W.19.

Fused Silica Prism for Spectrophotometry

Due to its extremely high purity, fused silica has considerably better transmitting properties in the ultra-violet region of the spectrum than natural quartz, and for this reason Unicam Instruments Limited have recently replaced the quartz prism in their SP. 500 ultra-violet spectrophotometer with a prism of this new material. The result has been to extend the useful range of the instrument from 200 mμ to the region of atmospheric absorption at 186 mμ, and to improve its performance in the important 200-250 mμ range.

Full details may be obtained from Unicam Instruments Ltd., Arbury Works, Cambridge.

High Temperature Connectors

Two advanced ranges of high temperature plugs and sockets capable of operating in conditions of supersonic flight have been produced by The Plessey Company Ltd.

These connectors, which are improved designs of the aluminium Mark 4 and standard ranges of plugs and sockets, have been introduced to meet the demand for higher working temperatures. The most stringent tests have been applied to these connectors, which have proved to be efficient at temperatures of up to +130° and +150°C; satisfying both the Ministry of Supply and Air Ministry requirements.

Full details may be obtained from The Plessey Co. Ltd., Ilford, Essex.

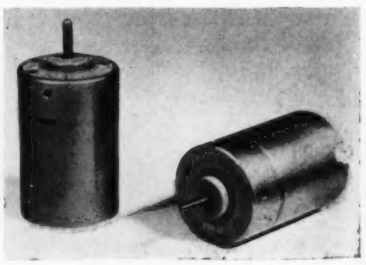
Motor Type P.M.1.C.

THIS motor, which is a modified version of the original motor P.M.1, is intended to have better climatic endurance and longer life under continuous operation than its predecessor. This motor is almost identical with motor type P.M.1.A which has been known as the Ministry of Supply Standard machine for some years. The motor P.M.1.C. is tested to R.A.E. Spec. EL.1703 Issue 4, and will withstand considerable adverse treatment.

Motor Performance:

		24 V	12 V
Nominal rating— continuous	...	80 g.cm 5,000 r.p.m.	80 g.cm 3,200 r.p.m.
Maximum output power		4·1 W	2·7 W
Efficiency at rating	...	33%	35%
Stall: Torque	...	190 g.cm	150 g.cm
Current	...	1 amp	1·3 amp
Current at rating	...	·52 amp	·65 amp

Full details may be obtained from R. B. Pullin & Co. Ltd., Phoenix Works, Great West Road, Brentford, Middlesex.



Motor, Type P.M.1.C.

Ultrasonic and High-frequency Recording Equipment

THE ultrasonic flaw detector Mark 5F is a multi-frequency instrument, designed specifically for use in production units, and for laboratory investigation and where the applications involved can adequately be met with probes having twin or common transmitter receiver transducers.

The ultrasonic flaw detector Mark 5AF is a single frequency instrument available for $1\frac{1}{2}$, $2\frac{1}{2}$ or 5 Mc/s operation. A specially developed amplifier is incorporated to give optimum performance when used with probes having single, twin or common transmitter receiver transducers. This facility for permitting all three normal methods of manual ultrasonic examination to be applied enables complete investigations to be made, and simplifies ultrasonic inspection procedures.

Either instrument can be used with a Kelvin Hughes two channel flaw alarm for semi-automatic inspection techniques. They may also be used in conjunction with the Kelvin Hughes depth and thickness gauge.

The sensitivity of these instruments is such that, depending upon application, probe and operating conditions, defects of the order of a $\frac{3}{64}$ in. (1·19 mm) flat bottom hole at $\frac{1}{8}$ in. (2·54 mm) from the top surface can easily be detected.

The Mark 6 flaw detector is a development of the Mark 5 flaw detector and facilitates contact, gap or immersion scanning techniques, photographic data recording plus optional additional monitoring circuits to permit the use of semi-automatic inspection methods. The instrument is designed for the dual role of production testing and laboratory investigation into transmission characteristics and for use with probes having single, twin or separate transmitter/receiver transducer heads.

A wide frequency and control range, allied to the calibration of key controls and a large, brilliant C.R.T. display permit a wider degree of application than has hitherto been possible with transportable ultrasonic equipment.

The equipment consists of two dimensionally identical display and control units, mounted in a specially designed trolley which incorporates accessory drawers and storage for the mains supply lead.

The two channel flaw alarm is an accessory for use with the Mark 5 series of portable flaw detectors and is designed to relieve operator fatigue of manual interpretation of signals on production flaw detection tests.

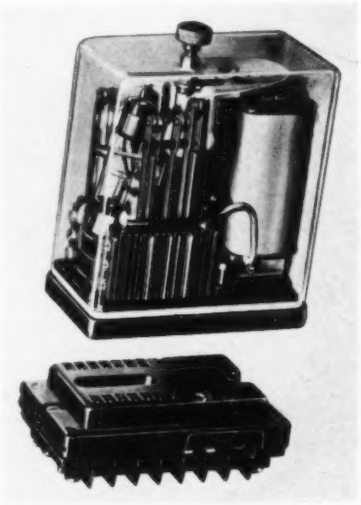
The device can be adjusted to respond to indication from defect signals in any section or only to signals occurring in a narrow strata which can be set anywhere in the cross-section of the material under test. Warning signals can be either audible or visual and the equipment is designed to 'fail safe' in the event of component or circuit breakdown. Sensitivity can be preset to a desired level and the two outputs "overlapped" to facilitate examination of certain areas at two different frequencies.

The Mark 3 depth and thickness gauge is an accessory to the Marks 5 and 6 flaw detectors and will measure the thickness of material from 0·1 in. to 4 in. without the necessity of circuit modifications. The principle is that of an acoustical delay line, wherein the depth gauge signal is superimposed upon the flaw detector trace and correctly phased by a variable control until the fault signals coincide, indicating the thickness of the material under test.

Full details may be obtained from Kelvin & Hughes (Industrial) Ltd., Livingstone College, Knotts Green, London, E.10.

C & S Plug-in Relays

THE plug-in d.c. mains relay, Type 2600B is for use in those control systems where the supply is from about 110 volts to 240 volts d.c. The contacts are of arc suppressing material and two of them have permanent magnet arc blow-outs. These latter contacts can be used to switch small motors, klaxons and similar inductive loads taking up to about 5 amps at 240 volts d.c. without any risk of an arc being maintained between the contacts.



Plug-in relay.

The other contacts can be used on 240 volts d.c. to switch such loads as lamps and relay coils. A total of six pairs of contacts can be fitted.

The plug-in mercury switch relay, Type 2600H, can have one or two mercury switches with N/O or N/C action rated at 6 amp at 500 volts or 240 volts d.c. or a fleeting contact or "quick-strike" mercury switch which gives a brief "make" when the relay is energised, but not when it is released, or the reverse. When only one mercury switch is fitted the relay can also have up to three pairs of dry contacts. The mercury switches move through a much greater angle than the armature. This gives such a margin of safety that excessive care is not needed in levelling the equipment and as small armature gaps and heavy return tension can be used the possibility of the armature sticking on is avoided.

Full details are available from D. Robinson & Co., 717 London Road, Hounslow, Middlesex.

"Domino" Miniature Unitors

THERE are three basic plug and socket versions comprising two 8-way types (one with four small and four large pins, the other with eight small pins) and one 12-way type. Surface and flush mounting metal shrouds are available to accommodate one, two or three unitors, thus giving a very wide choice of pin combinations and arrangements.

Body mouldings—which are of black, moisture and tracking resistant phenolic material—are coded on each side of both plugs and sockets to facilitate wiring and fault finding.

Plug pins are formed from brass and supplied either gold or silver plated. Socket pins are of beryllium copper, slotted to ensure good contact with the plug member. Each assembly has a locating centre pin which polarises the plug on engagement, and an 8 BA stud is provided for mounting the unitor on chassis or panel.

Now under development and soon to be made available is a miniature coaxial unitor L.1391. This unitor carries two miniature coaxial connectors and a locating spigot and can be accommodated in the same metal shrouds as used in the "Domino" range.

Full details may be obtained from Belling & Lee Ltd., Great Cambridge Road, Enfield, Middlesex.

Precision Pulse Generator

THE instrument consists of three main sections: stabilised power supply, voltage divider network and pulse forming network. Pulse amplitude is adjustable over the range 0-40 V by the main control and there is also incremental control which provides continuous variation over a range of 0-1·2 V with a linear accuracy of ±2 mV. Overall amplitude stability during an 8-hour period is better than ±0·05% (allowing for mains variation of ±5%).

A three-position switch selects pulse widths of 1, 5 or 25 microseconds. Pulse polarity may be either positive or negative at a repetition rate equal to mains frequency.

Full details may be obtained from Sunvic Controls Ltd., 10 Essex St., London, W.C.2.

Briticent Micro-Sonde

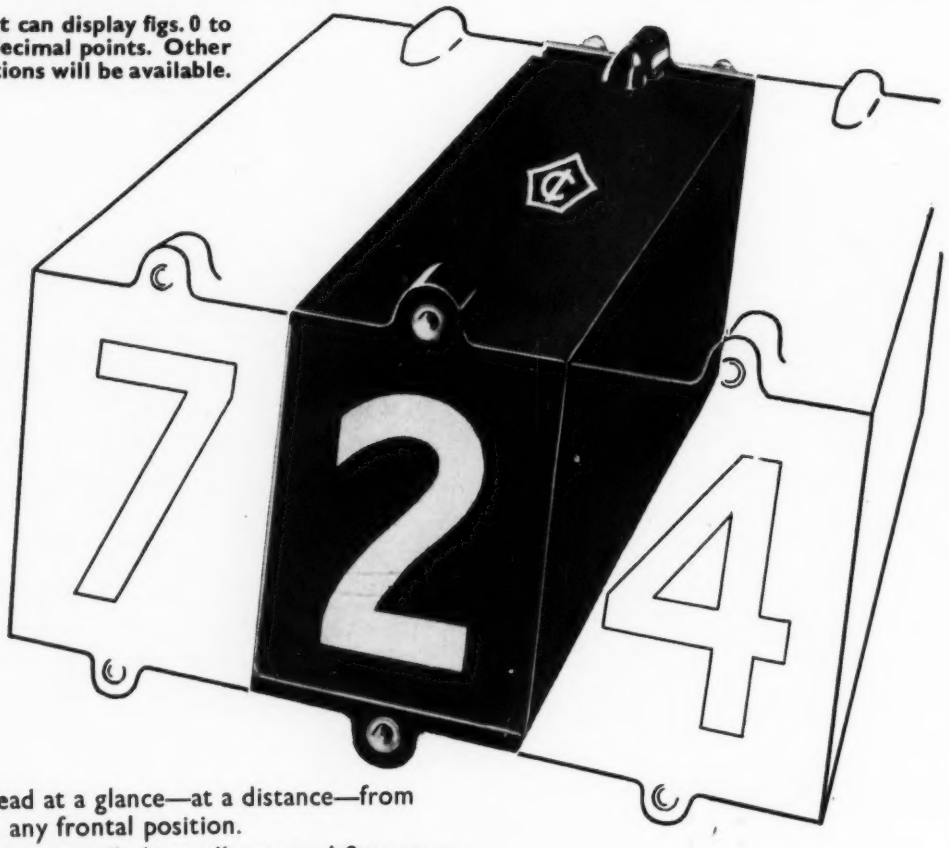
BRITISH Central Electrical Company Ltd. are introducing a complementary unit to their photo-electric contactor introduced last year.

This equipment comprises a control unit using a thyratron operated relay and operated by extremely small infra-red sensitive cells. The heart of the unit is a 3 mm diameter photo-electric receiver, whose minute size allows it to be placed in the smallest part of the machine, requiring negligible space. Due to its minute size, it can also be operated from a very narrow light or infra-red beam.

The photo-electric receiver can be supplied either mounted at the end of a coaxial screened flexible cable, or moulded in nylon, and fitted to an M.E.S. base; the latter mounting is preferable when it is to operate on a narrow beam. A specially designed housing accommodates this photo-cell receiver. The

a NEW
IN-LINE DIGITAL DISPLAY UNIT

Each Unit can display figs. 0 to 9 plus 2 decimal points. Other combinations will be available.



★ Read at a glance—at a distance—from any frontal position.

★ Exceptionally large illuminated figures or letters on front face.

★ High contrast for utmost visibility.

★ Any number of units can be grouped or panel mounted.

Write for full details.

We offer expert technical advice to solve your counting problems and, of course, in strict confidence. Our new range of counters are designed to meet the requirements of most industrial purposes.

Counting Instruments Ltd

COUNTING INSTRUMENTS LTD., 5 ELSTREE WAY, BOREHAM WOOD, HERTS.

Telephone: ELStree 1382-3-4

housing will also accommodate an M.E.S. lamp, and so constitute a projector. The housing assembly can be mounted and swivelled in any plane by the special mounting block and clip supplied. The control unit is mounted in a steel case, 4 in. × 4⅛ in. × 2¼ in. deep, which can be sealed to prevent interference. The chassis is assembled on a plug-in unit, and is mounted in the sheet-steel case on to a connector socket, which forms a terminal block for all connections. Floating contacts in the socket, and solid pins on the chassis, ensure alignment and low contact resistance. When plugged in, the chassis is locked in place by a stud which also completes the earth circuit. The control unit is also available without the sheet-steel case, for assembly with other equipment as part of an automation scheme in a control panel. Mounting is normally by means of three fixing holes. When supplied without the case, the connector socket can be simply affixed by means of two screws to a flat surface only 1 $\frac{1}{16}$ in. wide.

Activated by infra-red light, the photocell's output triggers a cold cathode thyratron, which in turn operates the contactor relay. This has an alternative control circuit for on and off states of the valve. The unit can thus be used to operate either when the cell is obscured, or when it is illuminated, i.e., to make or break the circuit. The circuit ensures perfect, reliable operation, and will operate correctly even with supply voltage variations of ± 20%, and within a temperature range of ± 40°C. The relay contacts will break a maximum current of 5 A a.c., or 1 A d.c.

With an operating time of only 50 milliseconds, the Micro-Sonde will:

Count units on assembly or packing lines at the rate of 900 per minute, using an integrating counter.

Control automatic weighing equipment processes.

Effect control by observing the movement of the pointer of measuring or indicating instruments, or any mechanical movement which will interrupt or affect the beam from a projector.

Automatically control moving stairways, lifts, conveyor belts, gates, doors, machinery safety guards, etc., and protect operators from dangerous machinery.

Control levels of liquids and solids, clear or opaque, insulating or conducting, corrosive or consumable, in pits, sumps, tanks, hoppers, silos, sight glasses, etc.

Automatically start and stop machines if they are not loaded or supplied with enough raw material for continuous operation, and will control the speed of feed of raw material from hoppers to a machine, silo or other container.

Control smoke emission, detect black smoke from chimneys, adjust automatic stoking plant, or sound alarm.

Provide reliable indication that the filling level of packaged goods is correct, and that tins and bottles are labelled.

Provide flame control on automatic boilers and flame failure protection.

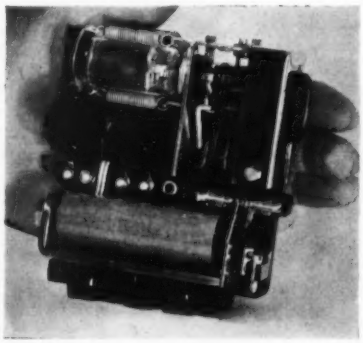
Constitute the nerve centre for alarm systems.

The prices are:

	£	s.	d.
Control unit complete ...	31	0	0
Micro-Sonde Receiver, mounted on screened co-axial cable (price depending on length of cable, between 6 ft. and 32 ft.) £1 12 6 to	2	0	0
Projector complete ...	1	5	0
Receiver complete with Micro-Sonde mounted in nylon	2	10	0

Delivery is from stock.

Full details may be obtained from British Central Electricity Co. Ltd., Briticent House, 6 to 8 Rosebery Avenue, London, E.C.1.



Micro-Sonde control unit.

"Grips On"

THE new "Grips On", a self-sticking stockmarker, provides a means of identifying the contents of KABI bench trays and storage bins, and it fits just as easily to all existing shelves, bins and racking, whether made from plastics, metal, wood or glass. The interlocking letters (or numerals) stick at a touch—need no nails, screws, glue or other fixatives—and can be removed, re-assembled and used over and over again.

Full details may be obtained from Precision Components (Barnet) Ltd., 13 Byng Road, Barnet, Herts.

PROXIMITY GUARD SAFETY SYSTEM PROTECTS WORKING CRANES

A new application of electronic control to shipbuilding practice has been evolved by James Scott and Co. (Electrical Engineers) Limited in their proximity guard system equipment which will be installed to safeguard tower cranes and will form part of the re-equipment of a Clyde yard. Tower cranes are controlled either visually or by telephone and the risk of collision is an inherent aspect of that use. By the system now devised, audible or functional warning is given when two or more moving parts of a structure or structures approach closer than the safety limits permit. The system can be arranged to protect cranes and other structures with slewing or elevating jibs, rotary and translational movement, providing only that the units are constrained to follow fixed paths, as in the case of rail-operated units. The system also protects the moving structure from collision with static structures such as buildings.

An example of this installation would involve the location of the combined visual and collision warning controls in the cabin of the major crane, where two cranes are operating on the same track. The equipment consists of units which are attached to the cranes giving electrical outputs determined by the jib angle and the position of the crane on its tracks. The information so provided is used to repeat on a scale model on the "indicator unit" the relative position of the two cranes and their jibs. By enlarging the jibs of the model to include a guard area, interaction of the guard areas occurs before the actual crane jibs collide. When interaction occurs an electrical circuit is completed which can be used to operate warning lights, sound alarm bells or automatically cut off power.

The subsidiary units which transmit the crane angles and positions consist of synchro-transmitters for the angular information and potentiometers for distance information. Connections between these and the indicator unit are via modified collector ring units on the cranes and trailing cables in addition to the main power conductors. The first application will be on cranes which are now being completed in Glasgow for installation in a Clyde yard. Other applications which are visualised include use of the system on constructional sites and failure of remote handling equipment when radioactive materials are involved.

Asia's First Atmospheric Receiver

THE Hyderabad Science Society, in co-operation with the Nizamia Observatory in Hyderabad, has erected a special atmospheric receiver for recording solar flares.

The apparatus, which includes a special 50 ft. high aerial manufactured by the society in its own workshop, is claimed to be the only one of its kind in Asia.

The Society is at present negotiating with the observatory for the installation of an electron-countering photometer by using scalers and a photo-multiplier.

This will enable them to measure the magnitude of stars with the latest technique.

The observatory has already taken up the preliminary work.

Electro-magnetic Isotope Separator

IN the National Physical Research Laboratory of the South African Council for Scientific and Industrial Research in Pretoria, a recently-completed electro-magnetic isotope separator will be installed in the cyclotron hall, and the beam of the cyclotron focused on its ion source.

The isotope separator collector will at the same time form the source of a beta ray spectrometer, which is to be installed in a new experimental hall that is nearing completion next to the underground cyclotron hall.

SOLARTRON

Why Joint Service Approval ensures a first-class instrument

The repetitive adoption of so many Solartron instruments by the Service Authorities is not just a happy accident. It points clearly to the fine quality of electrical and mechanical engineering of all Solartron products — and to their continuing reliability under adverse conditions of use.

Joint Service Approval is not easy to obtain. It is granted only after the most exhaustive series of environmental tests has been carried out on the prototype instrument. Providing a standard for the use of electronic equipment by the Armed Services, the detailed specifications for these tests have been framed with a reference of world-wide field operation — in conditions of torrid heat, Arctic snows or moisture-laden tropical jungle.

If these severe checks are unable to disclose a fault of design or construction, then it is proven beyond all doubt that the shocks of battle or transportation, the rigours of unskilled usage — or the day-by-day decay of a long shelf life, will have not the slightest effect on reliability.

How much more reliable then is the commercially available instrument after this "baptism of fire". Stresses and assault far beyond the normal requirements of commercial use have been applied — and you, the customer, reap the very substantial benefit.

These are just a few of the tests applied during the Services' searching examination of the prototype instrument.

Shock Testing

Impact testing is applied which simulates the forces likely to occur during transportation or active service.

Vibration

High-amplitude vibration analysis seeks out weak fixings, resonant members and insecure components wherever they may be.

Fungus & Corrosion

Specially cultured tropical fungi and atmospheres of corrosive content seek out materials which may support life or cause decomposition.

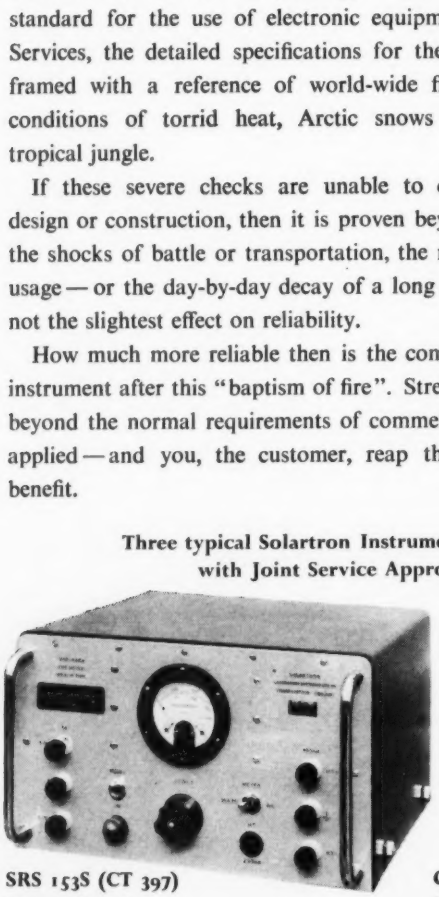
Humidity & Spray

Heavily laden with water, humid air is applied during prolonged performance monitoring. Sprays of specified intensity are used on cabinets and dust-covers.

Temperature Cycling

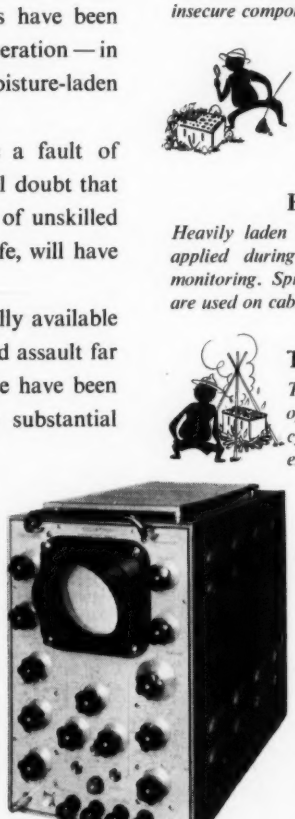
To ensure the reliability and proper selection of all components, the instrument is repeatedly cycled from icing conditions to those of extreme heat.

Three typical Solartron Instruments with Joint Service Approval



SRS 153S (CT 397)
Power Supply

- Lightweight, rugged construction.
- Unstabilised, 0 to 500 V output.
- Ideal for field and educational uses.



CD 523S2 (CT 386A)
General-Purpose Oscilloscope

- Proven instrument — many thousands in world-wide use.
- Bandwidth D.C. to 10 Mc/s.
- Top sensitivity 1 mV/centimetre.

CD 643S (CT 380)
Measuring Oscilloscope

- The most accurate 'scope in production — 2% measuring facilities.
- Bandwidth D.C. to 12 Mc/s.
- 100 shift diameters and up to 100 times 'X' expansion.

SEE US AT THE PHYSICAL SOCIETY EXHIBITION ON STAND 103

THE SOLARTRON ELECTRONIC GROUP LTD., THAMES DITTON, SURREY

TELEPHONE: EMBERBROOK 5522 CABLES: SOLARTRON THAMES DITTON

NEWS OF THE INDUSTRY

Solartron Pass the One Thousand Employees Mark

On 30th June, 1958, the number of employees was 820; but before September was out, it had passed the one thousand mark. About a quarter of the total employees are engaged in the development of new products. Therefore, the great increase in deliveries is substantially accounted for by continued increase in production per head and in putting floor space to the greatest possible productive use. Total deliveries were 42 per cent up on 1957 and nine times the volume of four years ago.

50,000 sq. ft of the 350,000 sq. ft works planned at Farnborough, Hants, are now occupied. N.A.T.O. orders for radar simulators total £400,000. Continental trade expanded with the wholly owned German subsidiary, Solartron Elektronik G.m.b.H. Solartron is fully prepared for the eventual introduction of Free Trade in Europe.

New electronic instruments include the process response analyser and measuring instruments using digital presentation technique for speed, temperature, pressure, flow and the Memoscope oscilloscope with infinite persistence trace.

Developments in data processing include unbonded stain gauge pressure transducers for nuclear power, aircraft and missile industries, data processing amplifiers for chemical process control and nuclear power stations, analogue magnetic tape recording equipment, for which a substantial order has been received for a Ministry of Supply project, "Minispace", etc.

The first production model of the Solartron electronic reading automaton is nearing completion. The production of others is being planned.

Precision mechanical engineering production in Solartron increased by 30 per cent with only a 15 per cent increase in personnel. Twenty new instruments went into production and six were modernised.

E.M.I. Closed-circuit TV for Merlin Reactor

Associated Electrical Industries Ltd. has placed an order with E.M.I. Electronics Ltd. to supply a specially designed underwater industrial television camera for observation inside the Merlin water-moderated nuclear research reactor at Aldermaston. The camera is 30 in. long and 3½ in. in diameter and will be enclosed in a pure aluminium water-tight housing.

It will work in conjunction with a standard E.M.I. camera which is being mounted on top of Merlin to provide a continuous view all around the reactor and to ensure that no unauthorised staff are near the reactor when it is in use.

Two ITM 14 viewing monitors will be rack-mounted in the reactor control room and a console monitor, capable of receiving pictures from both cameras, is being installed in the reactor conference room.

E.M.I. has recently supplied several tailor-made cameras for special projects in industrial television. The company designed a camera 3 in. in diameter and 48 in. long for the interior observation of the U.K.A.E.A.'s Pluto reactor at Harwell, and another special camera for observing prototype model aircraft under test in the National Physical Laboratory's wind tunnel at Teddington.

There is also a growing demand for E.M.I. closed-circuit television systems from factories, advertising agencies, department stores and other organisations. The Royal Navy's aircraft carrier *Ark Royal* has an E.M.I. installation, paid for by the ratings, which can show films, slides, ship's concerts and—when in coastal waters—B.B.C. and I.T.V. programmes.

B.B.C. Contract for New E.M.I. Camera

The B.B.C. has placed an order with E.M.I. Electronics Ltd. for nine Vidicon Camera Channels Type 201, for use in various interview studios throughout this country.

This is a new design television camera, using printed circuits and plug-in techniques to reduce weight and size to a minimum while at the same time retaining all the normal facilities. It is specially suitable for the export market, where broadcasting organisations frequently require a low-priced channel—the Vidicon camera costs approximately half as much as those using other types of pick-up tubes.

The Vidicon Camera Channel produces broadcast quality television signals on 405, 525 or 625 line standards, using E.M.I. Vidicon Tube Type 10667S, RCA Vidicon Type 6326 or any equivalent tube. The camera is fitted with a four-station turret and has optional remote control of focus, turret and lens aperture.

The control unit may be up to 500 ft away from the camera. By using Control Panel Type 216, the electrical operation of the channel can be remotely-controlled. This facility enables the operation of several channels to be carried out from a single operating position if so desired.

Picture Monitor Type 301 and Waveform Monitor Type 302 are available as auxiliary units.

Radio Aids in New Cargo Liner

Technicians from the Leith depot of The Marconi International Marine Communication Company, Limited, have fitted a full range of communications equipment and radio aids to navigation on board the new cargo liner *Cairnforth*, 8,200 tons. The new vessel employs an "Oceanspan VI" transmitter and an "Atlanta" receiver to handle radiotelegraph traffic on medium and high frequencies; and a "Reliance" transmitter, with an "Autokey" device and an "Alert" guard receiver, is installed for emergency use. A "Seaguard" auto alarm completes the emergency installation, and a "Salvita" portable transmitter/receiver is carried for use in lifeboats.

Long-range wireless bearings are provided by a "Lodestone" direction-finder, and visual and recording echometers are combined in a "Visagraph" installation.

The radar equipment chosen for the *Cairnforth* is Marconi Marine "Radiolocator IV" with a 15 in. display unit. The cathode ray tube is mounted almost vertically in the display console, so that the navigator looks down on the radar display as he would at a chart; and the large diameter tube enables two or more officers to observe and discuss the display together. This is a considerable advantage when handing over the watch in thick weather, or in identifying a radar landfall.

The Isotope School, A.E.R.E., Harwell

The school is part of the Isotope Division of A.E.R.E., and was set up in April, 1951, to give basic training in the safe and effective use of radioisotopes as a tool in research and industry.

In recent years the scope of the training has widened and the basic four-week courses have been supplemented by specialised courses, generally of shorter duration. These include isotopes in medicine, radiological protection and autoradiography, short orientation courses for directors and senior executives, courses for science teachers, for water chemists, and for international bodies such as the I.L.O. and W.H.O. Throughout the courses there is particular emphasis on practical work and on radiological safety.

So far over 1,000 students have enrolled for the 53 basic courses that have been held, and the participants in the 24 other courses bring the total to 1,725, nearly all of graduate level. They include representatives of 50 countries, 64% being from Great Britain and a further 12% from the Commonwealth.

Many branches of science are represented, but chemistry heads the list with 37%, followed by medicine with 18% and physics with 14%. 40% have come from industry, 30% from Government and other research laboratories including the U.K.A.E.A. Universities supply 22% and hospitals the remaining 8%.

A number of technical colleges are holding part-time courses and there are a few full-time courses and research teams in universities. There is, however, no sign of a reduction in the numbers of students wanting to come to the Isotope School at Harwell: in fact there is a continuing demand for new courses.

Foxboro-Yoxall 10 year service club dinner.

Foxboro-Yoxall Ten Year Service Club Dinner

THE 10th annual dinner of the Foxboro-Yoxall 10 year service club was recently held at the Wimbledon Hill Hotel. Just over a hundered members of the staff were present for the reception and dinner.

Afterwards some twenty new members were presented with their club emblems by Mr. Corodon S. Fuller, vice-president of the Foxboro Co. who had flown over for the occasion. In his welcome to the new members he emphasised the international character of the Foxboro Organisation and delivered a message of greeting from the secretary of the Foxco 10 year club in the U.S.A.

Mr. L. S. Yoxall, managing director of Foxboro-Yoxall Ltd., spoke of the successful inauguration, in May of last year, of the company's new factory at Redhill and outlined the plans for the further developments that remain to be completed.

New Solartron Anglo-American Agreement

THE Solartron Electronic Group, Ltd., Thames Ditton, Surrey, England, have concluded selling and manufacturing licensing agreements for the "Kintel" range of electronic products of the Cohu Electronics, Inc., of San Diego, California, U.S.A., which covers the whole world, with the exception of Sweden and North and South America.

The range of products includes d.c. digital voltmeter systems, d.c. data amplifiers, electronic galvanometers, digital readouts, electronic digital voltmeters, absolute d.c. power supplies, meter calibrators, d.c. voltage standards, strain gauge power supplies, microvoltmeters and ammeters, a.c. converters, accelerometers, and vibration and sound pressure measurement equipment.

Miniaturisation of Instruments

FRED FERRARIS (CLERKENWELL) LTD. are opening a new division for miniaturisation of instruments. This division will be undertaking research, development and production projects.

Rocol's Speedy Exports to East Africa

RECENTLY Rocol Ltd. received an air-mailed letter from their agents, the Twentsche Overseas Trading Co. Ltd., Nairobi, Kenya, which requested immediate delivery by air freight of a new order for "Molyspeed".

The agents, who cover the whole of British East Africa, stated: "As the Kenya Bus and Cement Factory want a guarantee that we can supply immediately, we would like to have some sent out by air at once."

Immediately Rocol sent a fifth of the order for 1,000 tins by van to Manchester Airport and caught the first aircraft out to Kenya. The remainder were sent by passenger train to the London Docks to join several thousand tins previously ordered by the agents for many replacement and monthly standing orders in hand.

Though the air freightage cost almost equalled the ex works cost of the 200 tins of "Molyspeed", the Board agreed with the Rocol director responsible for Africa, Mr. Edgar J. G. Wayman, that the goodwill created by such export speed was worth it, not only from their own viewpoint, but also for the prestige of British exporting generally.

The British Tabulating Machine Company's Overseas Subsidiary in East Africa

HOLLERITH (EAST AFRICA) LIMITED, recently established, is the latest of the six overseas subsidiary companies of The British Tabulating Machine Company Ltd. The new company has taken over from Hollerith Machines (South Africa) (Proprietary) Limited existing business in Kenya, Uganda, Tanganyika, and Zanzibar previously managed by that company on behalf of the parent company. Mr. G. C. Reed, M.B.E., is chairman of Hollerith (East Africa) Ltd., other members of the Board are Mr. J. C. Mundy, C.M.G., Mr. W. W. Baker, Mr. E. H. White and Mr. J. C. Smith, the last named acting as general manager.

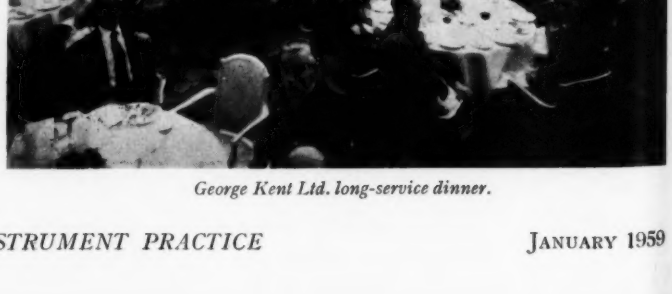
Change of Title

MESSRS. FREDERICK A. POWER & SONS (BOX STRAPPING) LTD., Landor Street, Birmingham, 8, manufacturers of a wide range of automatic and hand strapping machines for packages of all types will in future be known as Power Strapping Systems Ltd. This change applies only to the title of the company, policy and management remaining exactly as before.

Many Years of Service

GEORGE KENT LTD., of Luton, whose board changes were recently announced, marked the nostalgic occasion by a long-service dinner on Saturday, 1st November, at the Trocadero Restaurant, London, attended by over 300 employees with 25 years' service or more. Among the special guests were the Mayor of Luton, Alderman Mrs. F. M. Brash, and Mr. C. W. Salmon, of Cory-Wright & Salmon Ltd., the company's agents in New Zealand.

During the evening Commander P. W. Kent, the company's chairman, presented a number of 25-year and 50-year long-service certificates.



George Kent Ltd. long-service dinner.

Gresham Hermetically Sealed "C" Core Transformers

THE electronics division of Gresham Transformers Limited have recently gained full Joint Inter-Services Type Approval Certificate No. 812/9, for Hermetically Sealed "C" Core Transformers using a three-piece case construction as well as the more conventional two-piece deep drawn case construction.

Position Control of Massive Objects

A COMPREHENSIVE treatment of the position control of massive objects, by a team of experts led by Professor A Tustin, was published in November in the form of a paper, which, in effect, is a short textbook. Together with a supporting paper on dimensional relationships in control systems, by Professor Tustin, the main paper will appear as a supplement (No. 1) to Part C of the *Proceedings of the Institution of Electrical Engineers.*

The papers are entitled: "The design of systems for automatic control of the position of massive objects" and "Similarity and dimensional relationships in control systems".

Metropolitan-Vickers EM6 Electron Microscope

OF the Metropolitan-Vickers Type EM6 electron microscopes recently supplied a noteworthy installation is that at the Royal College of Surgeons of England. This equipment has been purchased for the college from funds provided by the British Empire Cancer Campaign, and will be used for research work with particular reference to cancer. It has a magnification of 120,000×, and for critical examination of the image incorporates a binocular telescope with a further magnification of 10×.

E.M.I.'s Computer Training Course

E.M.I. ELECTRONICS LTD. has organised a series of training courses at Hayes for Emidec programmers from customers' staffs and for other interested executives.

This is an intensive, practical course which, after introductory lectures on such matters as machine characteristics and flow charting, quickly gets down to cases. Each computer function is studied in detail and typical applications are mentioned throughout the course.

A special feature is the large proportion of exercise periods (over one third), during which at least four tutors are present. And the class is limited to about 15 students, so individual attention is assured during these important periods.

The course includes tours of several E.M.I. factories including, amongst others, those where computers and magnetic tapes are manufactured.

The panel of 15 lecturers includes graduate mathematicians, men with practical computing experience and office executives who know how a computer can best help the customer. The students, men and women, come from commercial undertakings, professional accountancy, Government departments and the Services, in Sweden, Italy and this country.

Instrument assembly room at Salford Electrical Instruments Ltd.

Emidec training courses last for three weeks. Several places have already been reserved for the next course, which starts on 12th January, and this aspect of E.M.I. Electronics' activities is likely to increase during the coming months.

J. Gordon's New Factory

JAMES GORDON & Co. LTD. have recently added a third building to their premises at Dalston Gardens, Stanmore. This provides accommodation for the enlarged Projects Department necessitated by the constantly expanding work in hand and the incorporation of the Power Plant Division of Elliott Bros. (London) Ltd. in the Gordon Organisation. The building also includes a new stores for spares and service requirements and a new canteen for the ever-increasing staff.

Nuclear Scientists from Warsaw

ISOTOPE DEVELOPMENTS LIMITED, Aldermaston, were visited recently by three scientists from the Institute of Nuclear Research, Warsaw.

The visitors, Mr. Sarvicki, Mr. Janikowski and Mr. Starzynski, were staying in England for a few weeks following an invitation given by Sir John Cockcroft during his visit to Poland.

The visitors displayed keen interest in all stages of development and production of nucleonic instruments, and in the equipment of the Active Laboratory. They also discussed the potential applications of radioisotopes in industry. At their Institute in Warsaw thay have a Russian swimming pool reactor which will be used for irradiation of chemicals, and for isotope production.

Change of Address

THE BRITISH THOMSON-HOUSTON EXPORT CO. LTD. (managing director Mr. E. V. Small) is now located at 33 Grosvenor Place, London, S.W.1, having transferred their offices from Crown House, Aldwych.

The telephone number of the new premises is Belgravia 7011.

New Instrument Assembly Room at Salford Electrical Instruments Ltd.

A NEW instrument assembly room has been built at the Peel Works (Salford) of Salford Electrical Instruments Ltd., a subsidiary of The General Electric Co. Ltd.

With a floor area nearly 10,000 sq. ft, the section is concentrated on the assembly of electrical indicating instruments of many types. Work benches are canopied and semi-pressurised to exclude dust, and between assembly points during the "flow-line" production, the work is placed in plastic boxes to ensure cleanliness. Both mechanical and electrical inspections are carried out at every stage of production. For test purposes, a general distribution board can supply any required a.c. or d.c. voltage.

Kelvin Hughes Mobile Demonstration Unit

NEW additions to the range of Kelvin Hughes ultrasonic flaw detection equipment were displayed in the company's Mobile Demonstration Unit in Olympic Way, Wembley, recently. The equipment is described in the New Instruments section.

This three day private exhibition prefaced a demonstration tour of industrial areas throughout the United Kingdom. The tour was designed to show industry the latest developments and facilities available in the techniques of ultrasonic flaw detection and high frequency recording. On view for the first time were entirely new developments in the general field of non-destructive test equipment.

American Automatic Control Council

THE American Automatic Control Council has set up review committees and schedules for U.S.A. papers to be presented at the first congress of International Federation of Automatic Control (IFAC) in Moscow in 1960. The Russian hosts for the 1960 meeting have prepared an ambitious agenda for technical sessions.

It covers three main areas: theory, components and measurement, and applications. Papers on automatic control theory will cover discrete data systems, continuous data systems, systems using computing devices, optimalising, multivariable systems, systems including a human operator, information theory, switching theory, stochastic processes, and simulators.

Papers on components and measurements will be sought covering the design and performance of transducers, amplifiers, computérs, logic elements, regulators, telemetry, final control elements, characteristics of components, methods of dynamic testing and reliability.

Each paper on application will pertain to a particular industry or type of controlled equipment. Typical examples: electrical machines, power systems, petroleum processing, chemical processing, ore refining, metal production, metalworking, transportation, materials handling, nuclear reactors, and heating and air conditioning.

Elliott Computer for W. & T. Avery Ltd.

PANELLIT LIMITED, Willesden, a member of the Elliott-Automation Group, have just supplied a three cabinet analogue computer to W. & T. Avery Limited, of Birmingham, for use in solving problems in hydraulics.

The machine has a total capacity of nearly 50 amplifiers and includes a number of non-linear units such as servo multipliers, new silicon diode arbitrary function generators and others.

It will be used by the Testing Machine Division of Avery's to assist in the development of hydraulic systems of advanced design to be used in their testing machines.

Panellit Limited, who specialise in data reduction and process control equipment, are now responsible for the production of Elliott analogue computers.

Wild-Barfield Electric Furnaces Limited

WILD-BARFIELD ELECTRIC FURNACES LTD., of Elecfurn Works, Watford, Herts., announce that they have received an order for a special 50 lb induction vacuum furnace from Bristol Aero-Engines Ltd., Filton House, Bristol. The furnace will be equipped with a high speed pumping system and three different sizes of crucible and coil will be supplied. A 22 in. diameter external mould chamber will be incorporated for the introduction of hot moulds.

Airmec—Microlambda Agreement

AIRMEC LIMITED have been appointed sole agents in the United Kingdom for the Microlambda Company, of Italy, manufacturers of precision microwave measuring instruments and ancillary equipment.

The range of instruments includes Klystron mounts, Magnetron power supplies, signal generators covering the 25 cm (L), 10 cm (S), 5 cm (Xb) and 3 cm (X) bands; co-axial adaptors, slotted lines, stub tuners and tunable probes; directional couplers, attenuators, wave guide tees and bends; noise factor test sets and mixers, etc.

Award for Plessey Employee

AN award of 100 gns. has been made by The Plessey Company Limited to one of their employees—Mr. F. J. Hancock, of Romford, who works in the Radio and TV Packaging Department at the company's Ilford factory.

Mr. Hancock has evolved a new method of packaging TV and radio sets by which many of the expensive pieces of corrugated paper previously used can be eliminated. The new method has passed stringent tests by the company and has been approved by the Packaging and Allied Trades Research Association.

It is the largest award so far made by Plessey for a suggestion put forward by an employee for consideration.

High Speed Testing of Comet 4 with Electronic Recorder

EACH mark on the chart of this recorder brought Comet 4 nearer to its maiden Atlantic flight. In the race to defeat Boeing's bid for the first commercial jet crossing of the Atlantic, the strip chart recorder was part of a system devised by De Havilland Aircraft Co. Ltd., for quick and accurate testing of wing stiffness.

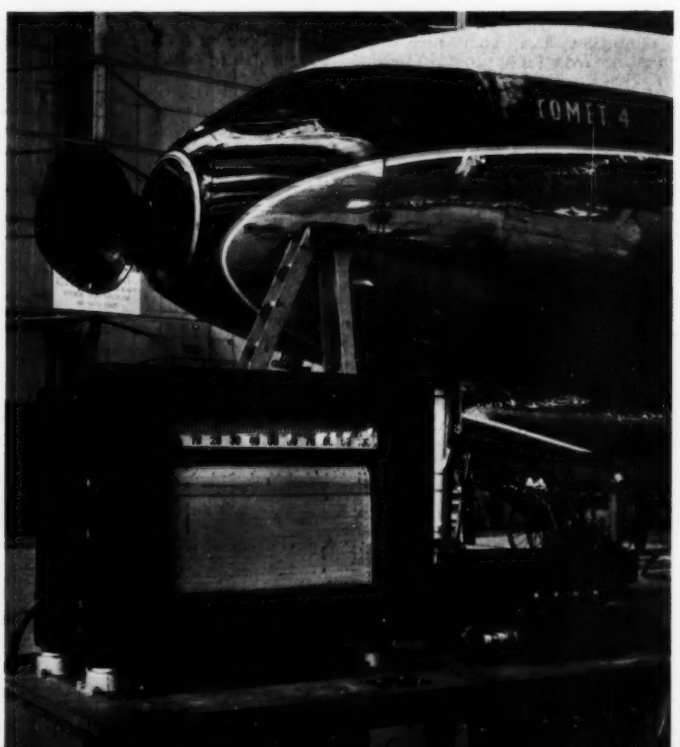
The tests were made by bending and twisting the wings with known stresses applied through a hydraulic jack, and measuring the resulting movements at particular points on the wing surface. In previous tests these measurements had been read and recorded manually by observers stationed at a number of points above and below the wings. The use of the multi-point recorder replaced the efforts of all these people, and automatically presented complete test results on a single chart. The result was a quicker and more accurate test run.

Wing surface movements were detected electrically by adjustable miniature potentiometers. The slider on each potentiometer carried a plunger which was kept in contact with the wing surface by a spring. Any movement of the wing therefore altered the slider's position and the voltage of the potentiometer. The recorder, supplied by Honeywell Controls Ltd., recorded the voltage of each of 22 potentiometers in turn, making a plot once every two seconds on average. A typical test sequence, which previously took about 20 minutes, was run through by this method in five minutes.

Instrument Division of Racal Engineering Ltd.

OWING to continuing expansion, a separate division has been formed by Racal Engineering Ltd. to deal with all matters relating to their range of instruments.

The new Instrument Division has its own development laboratories under the chief engineer, Mr. N. Elson, M.A., M.Sc., A.M.I.E.E., and also includes a special products section which will design, manufacture and install digital or non-digital instrumentation schemes for special applications.



Honeywell multi-point recorder used in pre-flight testing the Comet 4.

A strengthened sales force and a separate Instrument Service Department has also been created to enable comprehensive sales and servicing facilities to be available quickly throughout the whole of the United Kingdom. A new feature is that an applications engineer is always on call to advise on the application of digital techniques to general industrial problems.

Sales manager of the new Instrument Division is Mr. I. H. M. Campbell.

New Air-conditioned Gyro and Sextant Assembly Area

WITH the opening of new air-conditioned premises, Kelvin & Hughes (Aviation) Limited, of Barkingside, Essex, have considerably extended their facilities for the assembly and testing of precision gyro and optical instruments.

The primary objective of establishing ideal conditions for the manufacture of high precision instruments has necessitated stringent control over dress, movement and behaviour, but by careful planning and discussion, the resultant layout provides efficient production facilities and the maximum degree of operator comfort.

The area is divided into two distinct sections, flanked by a "goods in" and cleaning area, to which is confined all initial cleaning and machining operations. Critical work is carried out in pressurised cabinets in the largest room, which covers an area of 1,665 sq. ft and houses the gyro assembly and test equipment. This room is maintained at a slightly higher than atmospheric pressure and is the "ultra clean" area which controls the air and temperature conditions of the other rooms.

Thermotank Ltd. were responsible for the air control installation which permits eleven air changes per hour in summer and five in winter. Room temperature in the gyro and sextant room is thermostatically maintained at 68°F.

Illumination is by six banks of eighty-watt reflector type fluorescent tubes which are suspended above the ceiling on slotted angle support members. By this means an overall room illumination intensity of approximately 40 lumens per sq. ft is achieved.

Floors are covered in "Crestaline" P.V.C. sheeting and contain all the varied electrical and other services for the assembly and test benches which have been "tailor made" for the purpose. All working surfaces are covered in laminated plastic and each bench contains a swivel tray for delicate components in addition to fitted drawers and a cupboard for small tools and overnight storage of partly assembled instruments.

All services to equipment are run in ducts, the covers of which are finished in the same floor covering. Gaps are kept to a minimum in order to avoid dust traps in the floor.

The assembly benches are grouped in five rows of two benches flanking the dustproof assembly cabinet; all finished work being passed to an inspection and test console, forward of the benches.

All component parts are ultrasonically cleaned and dried in new, fully automatic equipment, bearings being cleaned in a specially adapted spray cleaning booth.

Working surfaces are entirely cleared of equipment and instruments at the end of each working day to facilitate complete vacuum cleaning. Assembled instruments are stored in heated cupboards fitted with silica gel drying agents.

Entrance to the rooms is made via a cloakroom where the operators remove their outer clothing and shoes and enter the "clean" cloakroom where special protective clothing is put on, consisting of a siren suit type of overall made from Egyptian cotton, close fitting cap and leather soled Grecian type slippers.

Before entering either cloakroom and immediately before entering the "clean" area, each person has to pass over a "Taccy" mat which removes any trace of dust from the soles of the shoes. Morning and afternoon tea breaks are taken in the outer cloakroom, where smoking is permitted only at these times.

X-ray's Important Role in Engineering Success of Marconi 250 kV Apparatus

MARCONI INSTRUMENTS LTD., St. Albans, report increasing interest by industry in radiographic inspection. Firms ordering the 250 kV constant potential Marconi equipment Type TF 1555B include Rolls-Royce Ltd., the Redheugh Iron and Steel Co. (1936) Ltd., and Vickers-Armstrongs (Engineers) Ltd. The latter are being supplied with two units, one of which is on a self-propelled mobile mounting equipped with steering, enabling it to be easily manœuvred about the shop floor or shipyard.

Two additional Marconi equipments have recently been delivered to Ministry of Supply ordnance factories, the United Kingdom Atomic Energy Authority's establishment at Dounreay is also making use of the apparatus, and a TF 1555B is being supplied to the Sheffield College of Commerce and Technology for instruction in radiographic techniques.

The wide kilovoltage range, from 30 to 250 kV in 2 kV steps, permits examination of components varying from plastic and aluminium items to ferrous sections up to at least three inches thick.

The equipment comprises a constant potential high-tension generator, a control unit, an oil cooler, and an oil-cooled shock-proof tubehead. The constant potential generator enables the whole of the high voltage energy to contribute to X-ray generation, ensuring maximum X-ray output and hence minimum exposure times.

Stanton Instruments Ltd. Guarantee

FROM December 1st, 1958, Stanton Instruments Limited are issuing a one year guarantee with all aperiodic, single pan, semi-micro and micro balances supplied in the United Kingdom. In addition, customers will receive one free service visit during this period which will ensure that the instruments are functioning correctly and are giving satisfactory service.

The scheme will be backed by the Stanton Service Organisation which operates from centres in London, Southampton, Bristol, Birmingham, Leeds and Edinburgh.

Twiflex Couplings Limited Agreement

TWIFLEX COUPLINGS LIMITED, The Green, Twickenham, Middlesex, a member of the Sheepbridge Engineering Group, announce the conclusion of an agreement with Zahnaderfabrik Renk AB, Gogginger Strasse, 70-81, Augsburg (13b), Germany (gearbox manufacturers), whereby the Renk Company will have sole manufacturing rights for the complete range of Twiflex automatic clutch couplings and flexible couplings for Germany. This agreement has been concluded with the primary object of producing in Germany a range of larger couplings of the Articulated and Rectiflex type for use on marine installations in conjunction with the Renk gearbox.

City and County of Newcastle Clean Air and Fuel Efficiency Exhibition

THE Cambridge Instrument Company Ltd. showed a selection of its wide range of fuel efficiency instruments at this exhibition, which demonstrated to manufacturers in the Newcastle area how costs could be lowered by greater efficiency in the use of fuel. The Cambridge range included indicators and recorders for flue gas composition (CO_2, O_2, CO), temperature, pressure, draught, etc., in all types of boiler plant. Comprehensive installations and inexpensive portable outfits were available.

Radio and Electronic Component Show, 1959

THE 16th annual Radio and Electronic Component Show, organised by the Radio and Electronic Component Manufacturers' Federation, is to be held at Grosvenor House and Park Lane House, London, W.1, from 6th April to 9th April, 1959.

Admission (from 10 a.m. to 6 p.m.daily) is by invitation only, applications for tickets to be made to the Secretary, R.E.C.M.F., 21 Tothill Street, London, S.W.1.

International Convention and Exhibition on Transistors

THE Radio and Telecommunications Section of the Institution of Electrical Engineers will be holding an International Convention on Transistors and Associated Semiconductor Devices at Earl's Court from 21st to 27th May. All the major industrial countries will be represented, including the U.S.A. and U.S.S.R. and at least 2,000 delegates are expected to take part.

The convention will be divided into 23 sessions. The opening session will be concerned with world trends in transistors and associated semiconductor devices. The remaining session will cover: materials; basic theory; characteristics and their measurements, and transistors as a circuit element; technology, design and manufacture; and application of transistors. Over 200 papers are expected to be submitted.

The exhibition will be essentially scientific in character and will cover all aspects of transistors and semiconductor devices and their applications. It is not intended to appeal to the general public.

The exhibition will be broadly divided into three sections. The first section will cover semiconductors and will be open to firms engaged in the manufacture of transistors and other semiconductor devices, materials and manufacturing techniques. The second section will be devoted to semiconductor applications and associated components and will be opened to firms engaged in the manufacture of equipment involving transistors and semiconductor devices and also to those supplying specialised components for use in transistorised equipment. The third section will show research exhibits from industrial and commercial research laboratories as well as from universities.

Engineering, Marine, Welding and Nuclear Energy Exhibition

THE Engineering, Marine, Welding & Nuclear Energy Exhibition, traditionally held in the autumn, has been rearranged to open in the spring of 1959. It will occupy the three halls of Olympia, London, comprising more than a quarter-million sq. ft of stand space, and already over 500 exhibitors have booked stands.

Engineers of every kind, users of diesel engines, operators of welding plant and equipment, and all those concerned with the harnessing of power—particularly nuclear power—should make a note that the exhibition will be open from April 16th to April 30th, 1959.

There will be more than 1,000 categories of engineering products and plant on show, including the latest developments in nuclear energy equipment.

Details of the exhibition itself can be obtained from the organisers, F. W. Bridges & Sons Ltd., Grand Buildings, Trafalgar Square, London W.C.2.

Convention on Thermonuclear Processes

THE Institution of Electrical Engineers has arranged a Convention on Thermonuclear Processes to be held in London on the 29th and 30th April. The final details of the programme have not yet been made, but the probable range of products to be covered is as follows:

Basic physics of thermonuclear processes.

Prototype British thermonuclear experiments, Zeta 1, Sceptre III and the linear pinch.

Constructional features of Zeta 1.

Design problems in future Zeta type systems.

Possibilities of direct conversion from nuclear to electrical energy.

Reviews of related work in the U.S.A. and the U.S.S.R. will also be included in the programme.

International Scientific Research Exhibition

THIS exhibition will be held at Olympia in October. Four main themes have been chosen as the pattern for the exhibition: health and food; materials; transport and communications; power and industry.

For the first time universities are being encouraged to take part in a public exhibition so that they can make known the very important part they are playing in modern technical and scientific research in all fields.

The visitor to the International Scientific Research Exhibition will be able to start from a point on the Avenue of Discovery and follow a picece of research from the point where it was an idea in somebody's mind to the finished product, representing a contribution to civilisation.

FORTHCOMING EVENTS

Jan. 14th. **The Society of Instrument Technology.** Data Processing Section. Manson House, Portland Place, London, W.1, at 5-30 p.m. Symposium on storage media. "Some Recent Developments in Punched Card Machines." D. F. Nettell. "Digitape—a Novel, Medium Speed, Low Cost, Recording Medium." E. J. Petherick. "Digital Storage on Punched Tape." M. E. Theis. "Storage and Processing of Digital Data on Magnetic Tape." D. W. Willis.

" 14th. **The British Institution of Radio Engineers.** South Wales Section. Cardiff College of Advanced Technology. "Computer Control of Machine Tools." H. Ogden.

" 15th. **The Society of Instrument Technology.** East Midland Section. Electricity Showrooms, Derby, at 6-30 p.m. "Railway Signalling Developments." J. S. S. Davis.

" 16th. **The Society of Instrument Technology.** Cheltenham Section. The Rotunda, Cheltenham, at 7-30 p.m. "The Microscope in Engineering." A. E. Bingham.

" 20th. **The Institution of Electrical Engineers.** Measurement and Control Section. Savoy Place, London, W.C.2, at 5-30 p.m. Discussion on d.c. amplifiers. Opened by K. Kandiah.

" 21st. **The British Institution of Radio Engineers.** West Midlands Section. Wolverhampton and Staffordshire College of Technology, Wolverhampton, at 7-15 p.m. "Learning Machines." P. Huggins.

" 21st. **The Society of Instrument Technology.** Newcastle Section. King's College, Stephenson Buildings, Newcastle-on-Tyne, at 7-0 p.m. "Applications of High Speed Strain Recording Equipment." R. Kasler.

" 21st. **The Society of Instrument Technology.** South Wales Section. Welsh College of Advanced Technology, Cardiff, at 6-45 p.m. "Data Logging." C. H. Copley.

" 22nd. **The Society of Instrument Technology.** Tees-side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7-30 p.m. "Design Work in an Instrument Development Section." T. W. Bain. "Electronic and Electrical Development Work at Wilton." L. English.

" 26th. **The Institution of Electrical Engineers.** Royal Festival Hall, at 6-0 p.m. Faraday lecture on "Automation." H. A. Thomas.

Jan. 27th. **The Society of Instrument Technology.** Symposium on flow measurement. Manson House, Portland Place, London, W.1, at 5-30 p.m. "Ultrasonic Flowmeter." R. E. Fischbacker. "Mass Flowmeters." P. Scanes. "Magnetic Flowmeters." B. W. Balls. "Aerofoils." C. E. R. Sams. "Propelier Flowmeters (Electronic)." F. R. Allen.

" 28th. **The Society of Instrument Technology.** Chester Section. Grosvenor Museum, Grosvenor Street, Chester, at 7-0 p.m. "Electrical Weighing—its Technique and Application." K. J. Railer.

" 29th. **The Society of Instrument Technology.** Grangemouth Section. Leapark Hotel, Grangemouth, at 7-0 p.m. "Electronic Weighing." K. J. Railer.

" 29th. **The British Institution of Radio Engineers.** South Midlands Section. Winter Garden, Malvern, at 7-0 p.m. "Industrial and Underwater Television." B. V. Soames-Charlton.

" 29th. **The British Institution of Radio Engineers.** South Western Section. School of Management Studies, Unity Street, Bristol, 1, at 7-0 p.m. "Recent Developments in Printed and Potted Circuits." H. G. Manfield.

" 30th. **The Society of Instrument Technology.** Scottish Section. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, at 7-15 p.m. "Measurement of Temperature using Fuel Systems." D. T. Royce.

" 30th. **Women's Engineering Society.** Hope House, 45 Great Peter Street, London, S.W.1, at 7-0 p.m. "Some Users of Electron Beams in Metallurgy." Mrs. I. H. Hardwich.

Feb. 4th. **The Society of Instrument Technology.** South Yorkshire Section. The University, St. George's Square, Sheffield, 1, at 7-0 p.m. "The Future of Solid State Electronics in Instruments." K. Kemhadjian.

" 6th. **The Society of Instrument Technology.** Fawley Section. Copthorne House, Fawley, Hants. "Laboratory and Industrial pH Measurements and Titrations." G. Mattock.

" 10th. **The Society of Instrument Technology.** Manchester Section. "Manchester" Room, Central Library, St. Peter's Square, Manchester, 1, at 6-30 p.m. "A Contractor's Approach to Instrumentation." J. Sheraton.

" 11th. **The Society of Instrument Technology.** Chester Section. Visit to Ellesmere Port Works, Associated Ethyl Co. Ltd.

" 11th. **The Society of Instrument Technology.** Data Processing Section. Manson House, Portland Place, London, W.1, at 5-30 p.m. "A Digital Instrumentation System for use in the Testing of Jet Engines." L. Airey.

PERSONALITIES

Mr. G. L. Ball.

Mr. L. Ingham.

Mr. G. L. Ball

Mr. Gordon L. Ball has been appointed general sales manager of Wayne Kerr Laboratories, Chessington, Surrey. He will be in charge of all sales activities in this country and abroad.

Before joining Wayne Kerr Laboratories, Mr. Ball was sales manager of the components division of the Plessey Company. He is a graduate of the I.E.E., and a member of the Sales Managers' Association.

Plessey Representative Honoured

The Plessey international representative in Amsterdam, Mr. E. G. Parramore, has been honoured by Queen Juliana of the Netherlands with the Knighthood of the Order of Orange-Nassau in recognition of his distinguished services to the Netherlands aircraft industry.

The award was presented to Mr. Parramore at a special ceremony in The Hague by Commodore L. Proost, Deputy Director of Ordnance and Supply, Royal Netherlands Air Force. Among those present were Mr. G. Kirk, British Commercial Attaché, Mr. C. Garland, Secretary to the British Air Attaché, and Mr. T. White Wilson and Mr. P. W. Faulkner, directors of Plessey International Ltd.

Mr. P. Gould

British Central Electrical Company Limited announce the appointment of Mr. Peter Gould as technical sales representative for the Eastern Area.

Mr. Gould was lately on the sales staff of William McGeoch as a technical representative, he has been connected with the wholesale technical trade for some 25 years.

Mr. P. Gould.

Professor Zepler to be next Brit.I.R.E. President

The Council of the British Institution of Radio Engineers announced that the president-elect for 1958-59 is Professor E. E. Zepler, who occupies the Chair of Electronics at the University of Southampton. His election was confirmed by members at the Institution's Annual General Meeting when he gave his presidential address.

Professor Eric Ernest Zepler was born in Herford, Germany, in 1898. He studied at the Universities of Bonn and Berlin and obtained his D.Phil. at the University of Würzburg in 1923. Subsequently, he continued his research work at the Physical Institute, Würzburg.

In 1925 Dr. Zepler joined the staff of Telefunken (Berlin) and was later appointed head of the receiver development laboratories. Eventually, he held the position of head of the firm's research laboratories until, in 1935, he left to join the Marconi's Wireless Telegraph Company at Chelmsford. He remained with the Marconi Company until 1940.

From 1941 to 1943 Dr. Zepler lectured at University College, Southampton. After a further three years as a lecturer at the Cavendish Laboratory, University of Cambridge, he returned to Southampton, and a year later was appointed head of the Department of Electronics. A Chair in Electronics was created in 1949 and Dr. Zepler became the first Professor.

Professor Zepler is especially well known as the author of a standard work on radio receivers—"The Technique of Radio Design", which was first published in 1943. He has also written papers on numerous aspects of circuit technique in professional and technical journals.

Elected a full member of the Institution in 1944, Professor Zepler served on the Education and Examinations Committee for some ten years, and was chairman from 1947 to 1954. He was Examiner in Radio Reception for the Institution's Graduateship Examination for several years, and represented the Institution on the Telecommunications Advisory Committee of the City and Guilds of London Institute. He has been a member of the Council since 1950 and also serves on the Professional Purposes Committee. He was elected a vice-president in 1952.

Rocol Appoints Head of London Technical Sales Department

Mr. David E. Burton, B.Sc. (Eng.), has been appointed to be in charge of the London Technical Sales Department at Ibex House, Minories, E.C.3, of Rocol, Ltd., Swillington, near Leeds, the specialist developers and manufacturers of molybdenised and other industrial lubricants.

Chloride Batteries Limited Appoint Assistant Sales Manager

Mr. Leslie Ingham, formerly manager of the industrial sales division, has been appointed assistant sales manager of Chloride Batteries Limited, of Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1, for the sales of all types of batteries in the United Kingdom and overseas.

Holder of the first prize and silver medal in electrical installation awarded by the City and Guilds Institute, he is also an associate member of the Institute of Electrical Engineers, a member of the Institute of Mining, Electrical and Mechanical Engineers, and has been awarded the Electrical Development Association Sales Engineers' Diploma.

Appointment of Scottish Technical Representative

The Coventry Gauge and Tool Co. Ltd. have appointed Mr. R. W. Boyd technical representative for Scotland. Mr. Boyd was for several years assistant chief draughtsman at the Brechin, Angus, factory of Coventry Gauge & Tool Co. Ltd.

New Managing Director for Sterling Industries Limited

Mr. Arthur Griffiths, O.B.E., M.I.P.E., has been appointed group managing director of Sterling Industries Limited, the engineering group of Chard, Somerset.

Mr. Griffiths has been director and general manager of the Daimler Company Limited, Coventry, since 1956. Prior to this he was director and general manager of F. Perkins Limited, of Peterborough, from 1948 to 1956 and previously held senior positions in the Ford Motor Company for 17 years.

Mr. A. Griffiths.

SOCIETY OF INSTRUMENT TECHNOLOGY

South Yorkshire Section

THE second meeting of the 1958/59 session of the South Yorkshire Section was held at the Sheffield University on Monday, the 10th November, 1958. A well attended meeting was invited to put instrumentation problems to a panel of experts.

The members of the panel were as follows:—

Mr. R. Bennett	—	B.S.A. Group Research Centre.
Mr. M. Thomas	—	Steel Peech and Tozer.
Mr. R. Owen	—	Honeywell Controls.
Mr. T. Land	—	Land Pyrometers Ltd.

A large variety of questions were asked; the subjects ranged from "Trouble shooting on Pressure Measuring Systems" to "Contamination of Rare Metal Thermocouples by Fluorine". Some very interesting discussions took place between members of the panel and people in the audience.

Mr. R. F. Wright, who acted as question master, proposed a very hearty vote of thanks to the panel members.

Midland Section Meetings

THE Midland Section of the Society of Instrument Technology opened their 1958/1959 session on 12th September with a subject of topical interest—air pollution—when Mr. C. A. J. Plummer, M.Sc., A.R.I.C., M.Inst.F., M.Inst.R., of the National Industrial Fuel Efficiency Service, read a paper on "Fuel Efficiency and Smoke Abatement".

Mr. Plummer first emphasised the harmful effects of atmospheric pollution: rickets, which was so prevalent in the early years of the Industrial Revolution, results from the reduction in ultra-violet radiation by smoke; a connection has been established between the incidence of lung cancer and the pollution of the air by coal and coal tar products; four thousand people are estimated to have died as a result of the London smog of 1952. This particular smog was caused by a phenomenon known as atmospheric reversal, which prevented the normal dispersion in the upper atmosphere of industrial waste gases and smoke from domestic fires.

The Clean Air Act, which came into force on 1st June, 1958, represents the first real attempt to combat this particular evil. The earlier Public Health Acts had placed upon local authorities the onus of proving smoke to cause a nuisance; the Clean Air Act, however, prohibits the emission of dark smoke—which is defined as shade 2 of the Ringelmann chart; some toleration of such smoke may be permitted, for example, during specified periods, when lighting up from cold, or through failure of plant or inability to obtain suitable fuel; until 1963, offenders may also plead as a defence difficulty in adapting equipment to prevent the emission of dark smoke. Local authorities must, however, be notified of the intention to install new equipment and may even ask to approve the design. The Act also contains provisions relating to grit and dust emission, the height of chimneys, the establishment of smoke control areas in which smoke is prohibited and certain fuels only are allowed.

Mr. Plummer then went on to discuss the complete combustion processes of the fuel, whether gas, oil or coal. When burning coal, the smoke is caused by hydrocarbons and hydrogen-rich vapours. If oil were inadequately atomised and the droplets were too large, there may be incomplete combustion, which again causes smoke. The speaker then explained the necessary requirements of percentage of air, temperature, volume of combustion space and turbulence which would give perfect combustion, with CO_2 at a maximum and with no more than a haze out of the chimney.

The interest which the paper aroused was shown by the lively discussion which followed, and Mr. Plummer dealt competently with the many questions which he was asked.

The Midland Section selected the oil industry for this season's sequence of evening visit, lecture and full-day visit, and they are very grateful to Midland Tar Distillers, Ltd. who granted them permission to visit their tar oils refinery at Four Ashes, on Tuesday, 23rd September. In spite of the unfavourable weather, twenty-five members assembled at the works, and passed a most interesting evening, which was made even more enjoyable by the generous hospitality of Midland Tar Distillers. The group was first taken on a tour of the works and, after a most acceptable buffet supper, took part in a discussion when questions were answered by Mr. Batten, the chief engineer.

During their tour of the works, members were able to see the processes involved in the production of naphthalene, a large range of naphtha solvents, motor benzole, phenol, the cresols and xylenols. The primary distillation of the tar is carried out at the Oldbury Works, and the processes at the Four Ashes begin with the removal of the tar acids from the oils by "washing", which, in the case of No. 2 fraction oil, is followed by the distillation of a naphthalene concentrate, which is again subjected to further treatment. No. 1 fraction oil, after the removal of tar acids and tar bases, is rectified, neutralised and then distilled into the well-known commercial cuts of the solvent naphtha range. Other by-products are puridine, picoline and a variety of the heavier base products. The aqueous solutions produced in the tar acid extraction unit are subjected to numerous processes, and result in a large range of products.

The refinery has three shaft lime kilns, making fresh burnt lime used in one of the processes, and also producing carbon dioxide. The boiler house consists of three water tube boilers, each with a maximum rating of 50,000 lb of steam per hour at 500 p.s.i.; steam for process purposes is available in ring mains at 300, 100 and 20 p.s.i.

Members were naturally interested to see the instrumentation used and they noted particularly some interesting special purpose instruments which had been developed by the company itself.

NEW ELECTRONIC COMPUTER FOR OFFICE WORK

A new electronic digital computer specifically designed to speed commercial office routine is being introduced by Ferranti Ltd.

Called "Pegasus 2", the new computer forms the centre of three different data-processing systems which are ideal for handling the administrative transactions within manufacturing organisations.

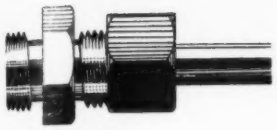
The first system is known as the "converter" data-processing system. The converter can operate on "off-line" working techniques, i.e., it can be preparing the next job for the computer or printing out the results from the previous job while the computer is engaged on a current project. As a result, the computer does not have to stand idle or slow down to work at the relatively lower speeds of conventional punched card machines.

The second system is known as the "direct" data-processing system whereby information on punched cards can be passed directly into or out of the computer. This system can be integrated with existing systems that already employ punched card installations.

The third system is the "common language" data-processing system which exploits new techniques and equipment for using punched paper tape as a data-processing medium.

Existing office machines such as typewriters, cash registers and accounting machines can be used in the ordinary way, automatically producing punched paper tape which provides the "common language" link between all the machines integrated in the system with the central computer.

The system will be of great value to organisations that do not employ punched cards, or for those organisations where information is derived from many different and geographically dispersed places but must be processed centrally, for example,



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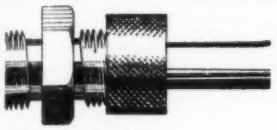
whatever the tube . . .



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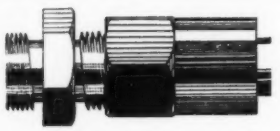

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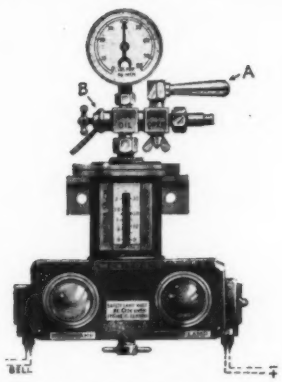

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The Baldwin Instrument Company have recently expanded their facilities to include a team of application and design experts who will give free advice on the use of the company's range of equipment.

The only limitations imposed are by the equipment's working pressures, which are 150 p.s.i. for compressed air, and 250 p.s.i. for hydraulic oil. In some cases water may be used as hydraulic fluid, and with all valves, vacuum can be handled comfortably.

Fig. 1 shows a simple system designed by the team, where the user required to clamp a workpiece prior to advancing a machining cutter under controlled speed. Here it was not necessary for the cutter cylinder to be withdrawn before clamping force was removed.

Cylinder 'A' is traversed forward to produce the clamping by the operator depressing plunger valve 'C' so applying a signal to the L.H. pilot of valve 'D', which changes over the air connections to cylinder 'A'.

At the end of its stroke, cylinder 'A' depresses the plunger of valve 'E' which relays a pilot signal on to the lower pilot of valve 'F', which will change over and apply air to air/oil reservoir 'G'. Oil will therefore be displaced into cylinder 'B' at a rate depending upon the setting of regulator 'H', and consequently, cylinder 'B' will advance at the correct speed so effecting the machining operation.

When cylinder 'B' has completed its full stroke, it will operate plunger valve 'K' which applies an air signal to R.H. pilot of valve 'D'. This valve will therefore change-over. Simultaneously, a signal will be applied by valve 'K' to the top pilot of valve 'F'. Nothing will happen with this valve, however, as a signal exists on the lower pilot also from valve 'E'. Cylinder 'B' will therefore remain in the fully extended position until cylinder 'A' releases valve 'E' after valve 'D' has changed over.

Cylinder 'A' will return to its original position after the reversal of valve 'D' and release valve 'E' which will, in turn, remove the pilot signal from the lower pilot of valve 'F'. The signal being supplied by valve 'K' will therefore change valve 'F' over and cause cylinder 'B' to return to its original position by the air which is applied to air/oil reservoir 'L'. Reservoir 'G' is connected to exhaust, cylinder 'B' will therefore return, either at the same speed dictated by regulator 'H', or at an unrestricted speed allowed for by the fitting of a check valve in parallel with the regulator. The system is then ready for a further initiation by depressing valve 'C'.

APPARATUS FACILITATES LENS TESTING

An apparatus devised by Dr. F. E. Washer, of the National Bureau of Standards, measures spherical and chromatic aberrations in lenses with a high degree of accuracy. The equipment is proving useful for the rapid testing of high-precision lenses such as those used in aeroplane cameras and in telescopes. With the aid of an optical T-bench equipped with nodal slides, a visual testing method is made possible.

By longitudinal spherical aberration is meant the variation in focal length for different annular zones of a lens. In other words, the focus for each zone occurs at a different place along the lens' optical axis. In order that corrections may be made for the resulting out-of-focus effects, accurate data must be obtained on the focal lengths of the various annular zones. These data are also important in lens design because they yield valuable information on expected performance and show the direction to be taken in improving the design.

When a light source is placed at the back focus of an annular zone of a lens with a longitudinal spherical aberration, the light from that zone emerges from the front of the lens at an angle to the lens axis. By isolating small areas along the lens' diameter, it is possible to measure this angular deviation, ϵ, for each zone. From these measurements the change in focus from zone to zone can be readily determined by the approximate formula

$$\triangle f = \frac{\epsilon}{h} f^2.$$

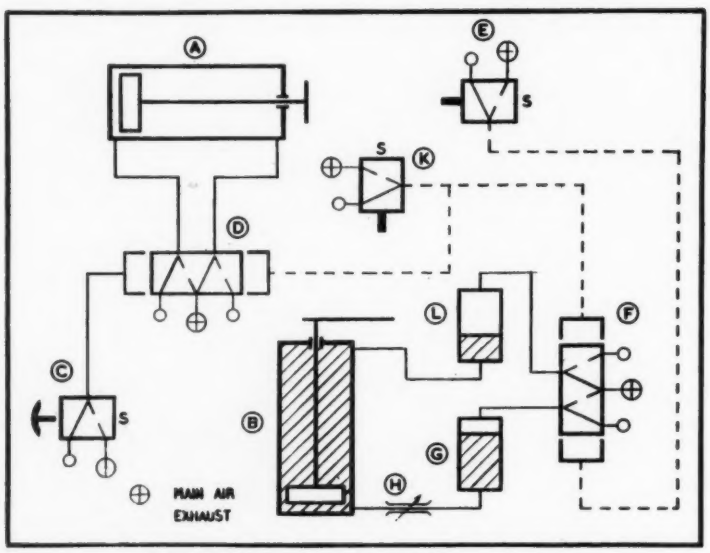
where $\triangle f$ is the variation of focus or longitudinal spherical aberration; ϵ is the measured angular deviation; h is the zone height (distance from lens axis); and f is the equivalent focal length of the lens.

The testing apparatus consists of two optical benches mounted on a strong metal table at right angles to each other in the form of a T. The cross bench carries a nodal slide with the viewing telescope, and a movable slide on which a pentaprism is mounted. The perpendicular bench carries a nodal slide that supports the lens under test, and a movable slide to which the reticle and light source are attached. The pentaprism is used to direct the light emerging from the lens under test to the telescope. The size of the telescope's aperture is limited as required by diaphragms with openings of from 1 to 10 mm.

When the slide with the pentaprism is moved along the cross bench, each annular zone along the lens diameter is isolated, and the angle ϵ, separating successive beams from the central beam, can be measured by the micrometers mounted on the telescope. Values for the longitudinal spherical aberration $\triangle f$ can then be computed for each zone height h. By plotting the values of $\triangle f$ as abscissae against h as ordinate, the typical spherical aberration curve is formed.

Information is obtained on longitudinal chromatic aberration by first determining the longitudinal spherical aberration for a series of colour filters. This is done by placing each filter in the light path between the light source and the illuminated reticle, and then by plotting the $\triangle f$ versus h curves from the data derived for each colour. The separation of these curves along the axis of abscissae is a measure of the longitudinal chromatic aberration.

For further technical details, see Optical T-bench method of measuring longitudinal spherical aberration, by F. E. Washer, *J. Res. Nat. Bur. Stand.*, **61**, 1958, 31.



Schematic of operational circuit fluid power service.

GRAY MAGNETOMETER IN THE SOLOMONS

A Geological Survey party has been carrying out magnetometer surveys in the Solomons Protectorate, using the magnetometer brought by Mr. F. Gray on board H.M.S. Cook. The magnetometer was tested on mineral bearing areas for the first time and the Geological Survey considers that it may revolutionise future magnetic surveys.

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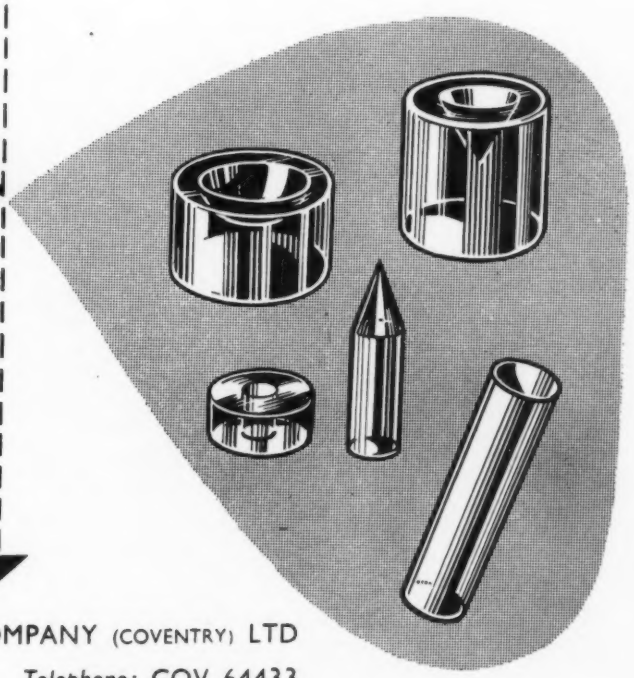

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continued on page 123

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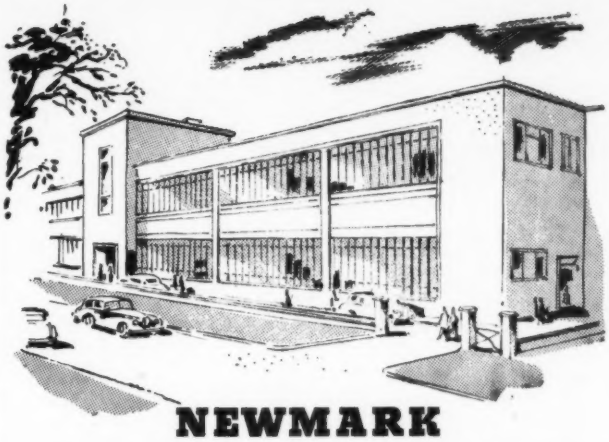

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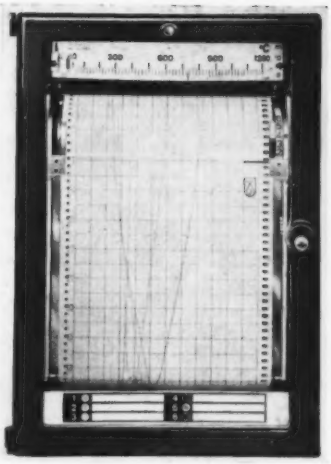

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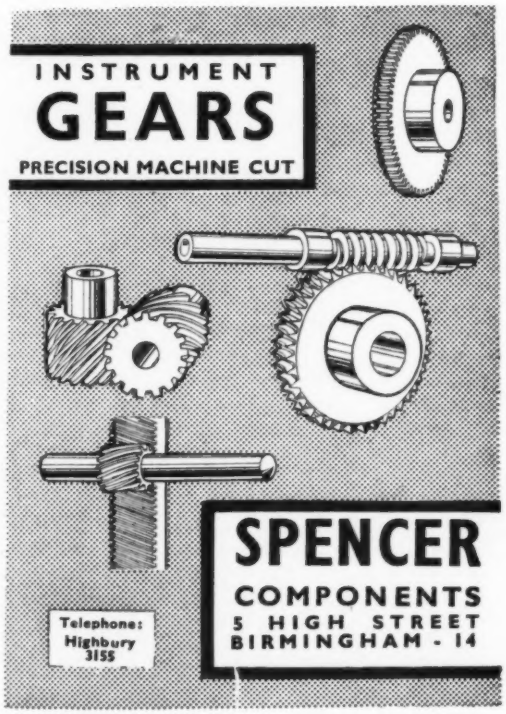

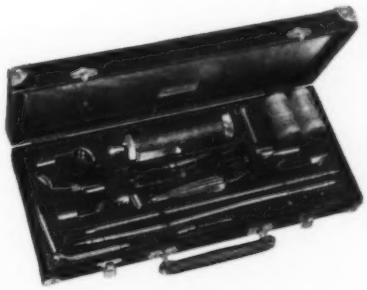

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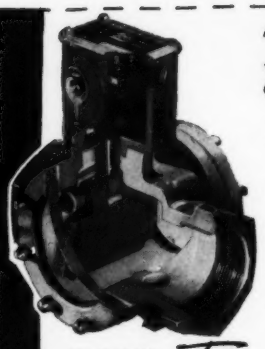

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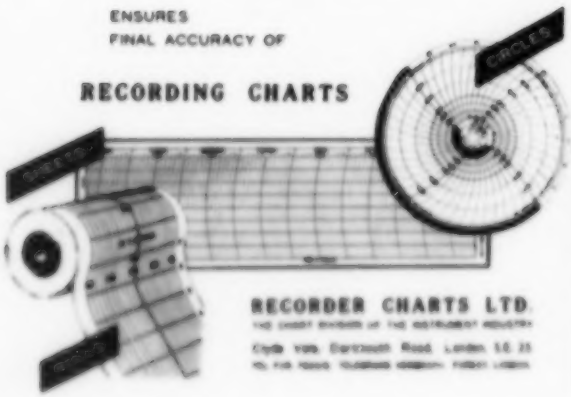

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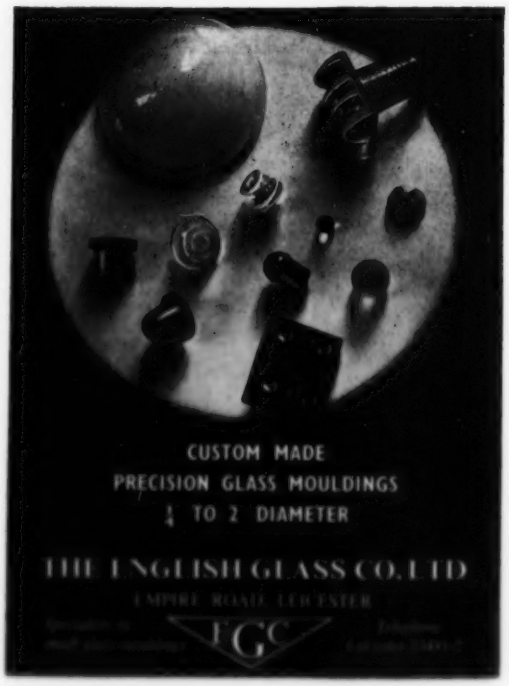

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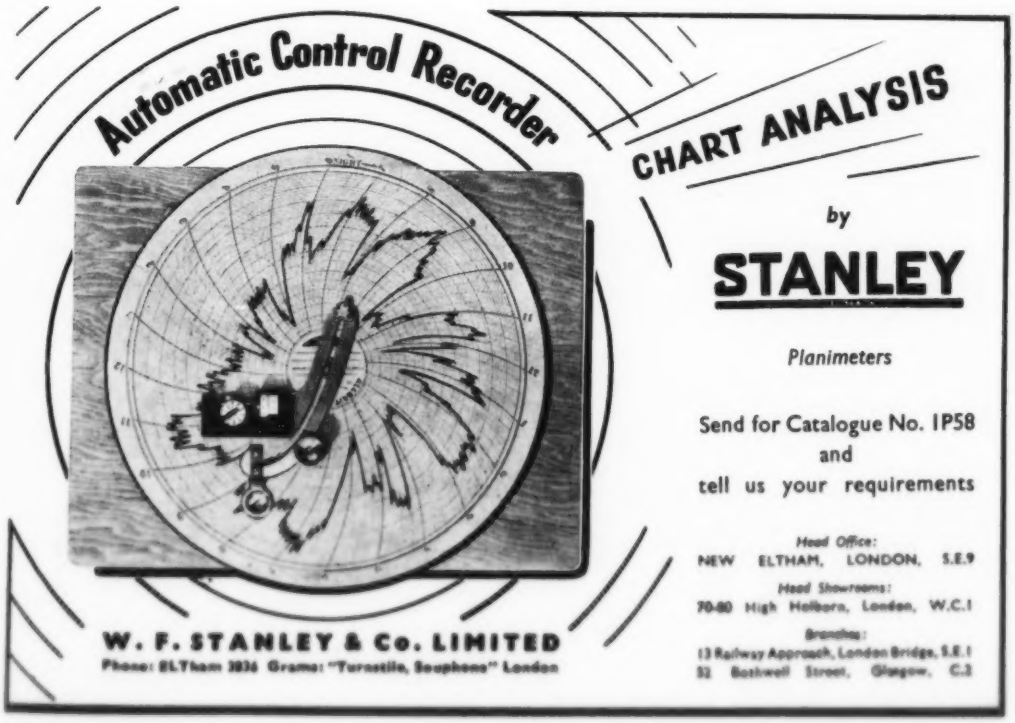

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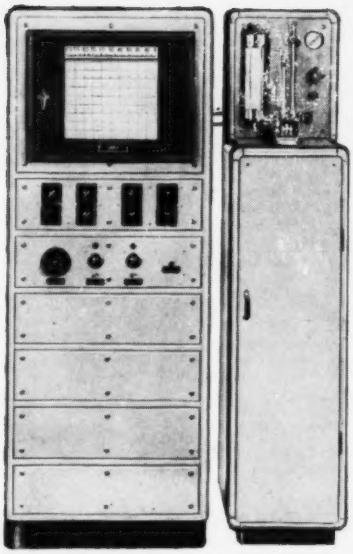

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